



**TITLE: 3X800 MW NLC TALABIRA
THERMAL POWER PROJECT
TECHNICAL SPECIFICATION**

SPECIFICATION NO. PE-TS-511-600-C005

SECTION - C

REV.NO. 0

DATE: 31 Jul, 2024

SHEET 1

OF 2

**NLC INDIA LIMITED
[NLCIL]**

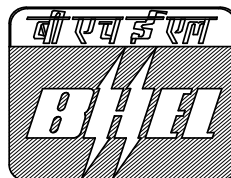


**NLC TALABIRA THERMAL POWER PROJECT
[3 x 800 MW]**

SECTION - C

TECHNICAL SPECIFICATION

SPECIFICATION NO. PE-TS-511-600-C005



**Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301**



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SPECIFIC REQUIREMENTS

Section-C covers specific technical requirements of the contract and shall be read in conjunction with BOQ, Section-D and other sections of the contract. In case of any conflict between the contents of BOQ and Section-C, Section-C will prevail over B.O.Q. In case of any conflict between Section-C and Section-D, Section-C will prevail over Section-D.



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha**

VOLUME: II-G/1

SECTION - I

GENERAL



Development Consultants Pvt. Ltd.

**Vol. II-G1/Section-I
General**



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VOLUME: II-G/1

SECTION-I

GENERAL

1.00.00 INTRODUCTION

This specification covers site survey, soil investigation, site development works, design and construction of Civil, Structural & Architectural works for the Coal based Thermal Power Plant to be constructed as Phase-I (3 x 800 MW) near Kumbhari & Tareikela villages, Jharsuguda District, Odisha. The scope of works covers complete Civil, Structural and architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the single EPC package comprising of Steam Generator (SG) & Auxiliaries package, Steam Turbine Generator (STG) & Auxiliaries package and Other Plant Structures including FGD.

This Section-I of Volume: II-G/1 lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. Documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

In case of any contradiction between any parts of the Bid Document with the other, requirement of most stringent one shall be applicable and in the event of conflict between requirement of any two clauses of this specification, or different codes / standards, the more stringent requirement as per the interpretation of Owner / Consultant is to be followed by contractor.

2.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards shall be identified in System Design Descriptions / Technical Specifications as appropriate. Unless otherwise stated, the latest editions/ revision of following codes and standards as on the original scheduled date of tender opening along with addendums/ amendments, if any, shall be followed:

2.01.00 General

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.(Latest Version)
- b) National Building Code of India.
- c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.
- d) IS-1256 : Code of Practice for Building Byelaws.

2.01.01

Earthwork

- a) IS-1498 : Classification and identification of soils for General Engineering purposes.
- b) IS-3764 : Safety Code for excavation work.
- c) IS-7293 : Safety Code for working with construction machinery.
- d) IS-4081 : Safety Code for blasting and related drilling operation
- e) Indian Explosives Rule 2008
- f) IS-9759 : Guidelines for Dewatering during construction.

2.01.02

Concrete

- a) IS-269 : Specification for 33grade Ordinary portland cement.
- b) IS-383 : Coarse and fine aggregate from natural sources for concrete.
- c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- d) IS-455 : Portland Slag Cement.
- e) IS-456 : Code of Practice for Plain and reinforced concrete.
- f) IS-460 : Test Sieves (all parts).
- g) IS-516 : Methods of test for strength of concrete.
- h) IS-1199 : Methods of sampling and analysis of concrete.
- i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.
- j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.
- k) IS 1489 : Part 1: Specification for Portland pozzolana cement Part 1 Fly ash based
- l) IS-1834 : Hot applied sealing compounds for joints in concrete.

- m) IS-2386 : Methods of test for aggregates for concrete (all parts).
- n) IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.
- o) IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).
- p) IS-3414 : Code of practice for design and installation of joints in buildings.
- q) IS-4948 : Welded steel wire fabrics for general use.
- r) IS-7320 : Concrete slump test apparatus.
- s) IS-7861 : Code of practice for extreme weather concreting (all parts).
- t) IS-8041 : Rapid Hardening Portland Cement.
- u) IS-8112 : Specification for 43 Grade ordinary Portland Cement.
- v) IS-12269 : Specification for 53 Grade ordinary Portland Cement.
- w) IS-10262 : Recommended guidelines for concrete mix design.
- x) IS-13920 : Ductile Design and Detailing of RC Structures Subjected to Seismic Forces.

2.01.03

Foundations

- a) IS-1904 : Code of practice for design and construction of foundations in soils: General requirements.
- b) IS-2950 : Code of practice for design and construction of raft foundations.
- c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).
- d) IS 2911 : Code of practice for Design and Construction of Pile Foundations (All Parts).

2.01.04

Loading

- a) IS-875 : Code of practice for design loads (other than earthquake) for buildings and structures.
- b) IRS : Bridge Rules of Government of India, Ministry of Railways (Railway Board).

2.01.05

Masonry

- a) IS-712 : Building limes.
- b) IS-1077 : Common Burnt Clay Building Bricks.
- c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.
- d) IS-1528 : Methods of sampling and physical tests for refractory materials.
- e) IS-1597 : Code of practice for construction of stone masonry (all parts).
- f) IS-2212 : Code of practice for brickwork.
- g) IS-2116 : Sand for masonry mortars
- h) IS-2185 : Concrete masonry units.
(all parts - Hollow and Solid concrete blocks).
- i) IS-2250 : Code of practice for preparation and use of masonry mortars.
- j) IS-2572 : Code of practice for construction of hollow and solid concrete block masonry.
- k) IS-2691 : Burnt clay facing bricks.
- l) IS-3414 : Code of practice for design and installation of joints in buildings.
- m) IS-3495 : Methods of tests of burnt clay building bricks.
- n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.
- o) IS-4860 : Acid Resistant Bricks.
- p) IS 13757 : Specification for burnt clay fly ash building bricks

2.01.06

Doors, Windows & Ventilators

- | | | | |
|----|---------|---|--|
| a) | IS-399 | : | Classification of commercial timbers and their zonal distribution. |
| b) | IS-883 | : | Code of practice for design of structural timber in building. |
| c) | IS-1003 | : | Timber paneled and glazed shutters (all parts). |
| d) | IS-1038 | : | Steel doors, windows and ventilators. |
| e) | IS-1081 | : | Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators. |
| f) | IS-1361 | : | Steel windows for industrial buildings. |
| g) | IS-2835 | : | Flat Transparent sheet glass |
| h) | IS-1948 | : | Aluminium doors windows and ventilators. |
| i) | IS-1949 | : | Aluminium windows for industrial building. |
| j) | IS-2191 | : | Wooden flush door shutters (Cellular and hollow core type). |
| k) | IS-2202 | : | Wooden flush door shutters (solid core type). |
| l) | IS-3103 | : | Code of practice for Industrial ventilation. |
| m) | IS-3548 | : | Code of practice for glazing in buildings. |
| n) | IS-3614 | : | Specification for metallic and non-metallic Fire check doors (all parts). |
| o) | IS-4021 | : | Timber door, windows and ventilator frames. |
| p) | IS-4351 | : | Steel door frames. |
| q) | IS-6248 | : | Metal rolling shutters and rolling grills. |

2.01.07

Roof & Flooring

- | | | | |
|----|---------|---|---|
| a) | IS-2204 | : | Code of practice for construction of reinforced concrete shell roof. |
| b) | IS-3201 | : | Criteria for the design and construction of precast concrete trusses and purlins. |

- c) IS-2210 : Criteria for Design of R.C. shell structures and folded plates.
- d) IS-809 : Rubber flooring materials for general purposes.
- e) IS-1195 : Bitumen mastic for flooring.
- f) IS-1196 : Code of practice for laying bitumen mastic flooring.
- g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors.
- h) IS-1237 : Cement concrete flooring tiles.
- i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.
- j) IS-2114 : Code of practice for laying in situ terrazzo floor finish.
- k) IS-2571 : Code of practice for laying in situ cement concrete flooring.
- l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping.
- m) IS-5766 : Code of practice for laying burnt clay brick flooring.
- n) IS-1197 : Code of practice for laying of rubber floors.
- o) IS-2441 : Code of practice for fixing ceiling coverings.

2.01.08 **Waterproofing**

- a) IS-1322 : Bitumen felts for waterproofing and damp proofing.
- b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.
- c) IS-1609 : Code of practice for laying damp proofing treatment using bituminous felts.
- d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.
- e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

- f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
- g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.
- h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

2.01.09 Membrane Waterproofing

- a) ASTMD-1076 : Solid Content
- b) ASTMD-1475 : Specific Gravity
- c) ASTMD-412 : Elongation
- d) ASTMD-2240 : Hardness
- e) ASTMD-822 : Water vapour transmission resistance

2.01.10 Soil Engineering

- a) IS-1498 : Classification and identification of soils for general Engineering purposes.
- b) IS-1892 : Code of practice for sub-surface investigation for foundations.
- c) IS-2131 : Method for standard penetration test for soils.
- d) IS-2720 : Methods of test for soils (all parts).
- e) IS-10379 : Code of Practice for Field Control of Moisture and compaction of soils for embankment and subgrade.

2.01.11 Water Supply, Drainage & Sewerage

- a) IS-404 : Lead pipes
- b) IS-458 : Pre-cast Concrete pipes (with and without reinforcements)-specification
- c) IS-651 : Salt glazed stoneware pipes and fittings.
- d) IS-771 : Glazed fire-clay sanitary appliances (all parts).
- e) IS-774 : Flushing cisterns for water closets and urinals (other than plastic cisterns)-Specification.

f)	IS-783	:	Code of practice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
q)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
r)	IS-3486	:	Cast iron spigot and socket drain pipes .
s)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
t)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
u)	IS-1538	:	Cast iron fittings for pressure pipes for water, gas and sewage.
v)	IS- 1729	:	Cast Iron/Ductile Iron Drainage Pipes and Pipe Fittings for Over Ground Non-Pressure pipeline Socket and Spigot series.
w)	IS-784	:	Prestressed concrete pipes (Including Fittings)- Specification.

- x) IS-1726 : Cast iron manhole covers and frames.
- y) IS-5961 : Cast iron grating for drainage purposes.
- z) IS-5219 : Specification for cast copper alloys traps: Part1 "P" and "S" traps.
- aa) IS-772 : General requirements for enamelled cast iron sanitary appliances.
- bb) IS-775 : Cast iron brackets and supports for wash basins and sinks.
- cc) IS-777 : Glazed earthenware wall tiles.
- dd) IS-2548 : Plastic water closet seats and covers (all parts).
- ee) IS-2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

2.01.12 Paving & Road Works

- a) IS-73 : Paving bitumen
- b) IS-702 : Industrial Bitumen
- c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220
- d) Practice followed by Indian Road Congress (all parts).

2.01.13 Earthquake Resistant Design

- a) IS-1893 (all parts) : Criteria for earthquake resistant design of structures.
- b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

2.01.14 Structural Steelwork

- a) IS-800 : Code of practice for general construction in steel.
- b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line towers (all parts).
- c) IS-806 : Code of practice for use of steel tubes in general building construction.

- | | | | |
|----|---------|---|--|
| d) | IS-808 | : | Dimensions for Hot Rolled steel beams, Columns, channels and angle sections. |
| e) | IS-813 | : | Scheme of symbols for welding. |
| f) | IS-814 | : | Covered electrodes for manual metal arc welding of carbon and carbon manganese steel. |
| g) | IS-816 | : | Code of practice for use of metal arc welding for general construction in mild steel. |
| h) | IS-817 | : | Code of practice for training and testing of metal arc welders. |
| i) | IS-818 | : | Code of practice for safety and health requirements in electric and gas welding and cutting operation. |
| j) | IS-819 | : | Code of practice for Resistance spot welding for light assemblies in Mild Steel. |
| k) | IS-919 | : | Recommendations for limits and fits for Engineering. |
| l) | IS-1024 | : | Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading. |
| m) | IS-1161 | : | Steel tubes for structural purposes. |
| n) | IS-1182 | : | Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates. |
| o) | IS-1239 | : | Mild steel tubes, tubulars and other wrought steel fittings (all parts). |
| p) | IS-1363 | : | Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia. 6 to 24 mm). [all parts] |
| q) | IS-1364 | : | Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts] |
| r) | IS-1365 | : | Slotted countersunk flat head screws (Common Head Style) - Product Grade A |
| s) | IS-1367 | : | Technical supply conditions for threaded steel fasteners. |

t)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
u)	IS-1608	:	Method for tensile testing of steel products.
v)	IS-1730	:	Dimensions for steel plates, sheets, strips and Flats for structural and general Engineering purpose.
w)	IS-1731	:	Dimensions for steel flats for structural and general Engineering purposes.
x)	IS-1852	:	Rolling and cutting tolerances for hot rolled steel products.
y)	IS-2016	:	Plain Washers
z)	IS-2062	:	Hot rolled medium and high tensile structural Steel
aa)	IS-2074	:	Ready mixed paint, air drying, red oxide zinc-chrome, priming.
bb)	IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
cc)	IS-3613	:	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
dd)	IS-3664	:	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
ee)	IS-3757	:	High strength structural bolts.
ff)	IS-4000	:	High strength bolts in steel structures.
gg)	IS-4759	:	Hot dip zinc coatings on structural steel and other allied products.
hh)	IS-5334	:	Code of practice for Magnetic Particle Flaw detection of welds.
ii)	IS-7215	:	Tolerances for fabrication of steel structures.
jj)	IS-7280	:	Bare-wire electrodes for sub-merged arc welding of structural steels.
kk)	IS-7318 [Part-I]	:	Approval test for welders when welding procedure approval is not required.

- II) IS-8500 : Structural steel – micro-alloyed (medium and high strength qualities).
- mm) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.
- nn) AWS D.1.1 : Structural Welding Code.

2.01.15

Painting

- a) IS-348 : Specification for French Polish.
- b) IS-427 : Specification for Distemper, dry colour as required.
- c) IS-428 : Specification for Distemper, oil emulsion, colour as required.
- d) IS-1477 : Code of practice for painting of ferrous metal
[I & II]
- e) IS-2338 : Code of practice for finishing of wood and
[I & II] wood based materials.
- f) IS-2339 : Specification for Aluminum Paints for general purposes in dual containers.
- g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.
- h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.
- i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.
- j) IS-5410 : Specification for cement paint.

2.01.16

- a) Indian Road Congress (IRC) Bridge Codes
- b) Indian Railway Standard Bridge Rules

2.01.17

Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

3.00.00

SCOPE OF CIVIL WORKS

The scope of civil work comprises all necessary investigations, survey, foundations, building, superstructures and infrastructure required for the successful completion and operation of the Thermal Power Plant to be constructed for 3x800 MW units. The FGD system shall be provided to treat the flue gases so produced in the furnace in order to keep the SOX value within the prescribed norms as per the MoEF&CC Gazette Notification S.O.3305(E) dated 07-12-2015 in respect of revised SO₂ emission norms.

The work under this Section consists of all Civil & Structural and Architectural works but not limited to items mentioned below.

- Topographical Survey in Plant Area including Raw water reservoir and all other area which are in Contractor's scope.
- All area grading works (refer Section A) & Micro grading, levelling & dressing are in Contractors scope (finished grade levels shall be as mentioned elsewhere). The contractor may visit the site and do survey to assess the variation, if any, in contour details furnished and to assess the actual site condition before quoting
- Geo-Technical investigation for all the areas under the scope of the contractor.
- Demolition of existing structures / facilities, if any encountered within the plant premises and all other area which are in EPC scope, and site clearance (The contractor may visit the site to access before quoting)
- Plant Roads as shown in the Plot Plan and RCC Box Culverts as per system requirement. Inspection road for Raw water reservoir (as per plot plan) are in EPC scope. Only RCC box culverts shall be provided for drainage and for all the underground conduits at road crossings.
- Boundary walls/Fencing in buildings, if required from statutory point of view (switchyard, transformers area, stores, etc)
- Storm water Drainage network for the entire plant area.
- Water supply, drainage and sewerage works for the entire plant area.
- Controlled blasting shall be permitted as applicable with necessary statutory approval to be obtained by EPC contractor as required.
- Tree cutting and uprooting of trees in plant area, Raw water reservoir and all other areas in Contractors scope. Useful material there off shall be handed over to owner's site in charge
- Contractor shall obtain necessary approval from statutory authority for entire EPC package where ever required including tree cutting. Owner

shall support by way of giving letters etc. for obtaining approvals.

Plant buildings and Structures / Facilities under the scope of work of contractor:

All Civil & Structural works for the following buildings/structures are to be completed: Also refer Section 3.00.00 of Volume II / G-1 Section-IV.

Boiler and its related Auxiliaries

- Mill and Bunker Building
- Boiler foundation ,Fan, Mills etc
- Foundation for PA, FD & ID Fans etc shall be provided as per manufacturer's proven practice.
- Boiler Maintenance Building
- Bottom ash Hopper
- ESP Foundations & Equipment foundations
- ESP Control Building.
- Fuel Oil Unloading-Cum- Pressurizing Pump House
- Fuel Oil Dyke
- Foam Pump House Building (RCC)
- BA Overflow sump
- Compressor Shed in Ammonia Storage Area
- SG area paving including necessary drains.
- Auxiliary Boiler MCC and Control Building.
- MCC/Operator room for SCR (common for all the three units)
- RIO-cum-VFD Panel Room
- Auxiliary Boiler Foundations.
- Blowdown Tank
- Plant IA/SA Compressor House
- All foundations for other technological requirements
- All civil and structural works related to Ammonia storage area as per system/process requirements

Turbine and its related Auxiliaries

- Turbine Building Substructure and Superstructure with EOT Crane.
- TG foundation including column & deck slab

- Service Building
- CPU Regeneration Building
- ACW Pump house for each unit
- Air Washer Room for each unit on roof of each unit ACW Pump House
- A/c Plant Building and inert gas room
- Civil and structural works for transformers and yard civil works including transformer foundation, paving, burnt oil pits and fencing etc.
- CST Pump Shed
- DG Plant Shed with foundation for supporting skid mounted DG Sets
- Condensate Storage Tank Foundation
- Cycle / Scooter Stand Car Parking near service building.
- Equipment Foundation
- All pipe and cable racks including foundations, pipe & cable trenches, duct bank etc.
- Rails and rail road.

Coal Handling System and its related Auxiliaries

- Receiving Tower
- Crusher House
- Drive House
- Junction Towers
- Conveyor gallery and Trestles
- CHP Control room cum Switchgear room
- Pump cum compressor house for DSS/DFDS
- Structural Steel Shed for Dozers
- Coal Handling system maintenance Building
- Coal Pile Run Off Pond
- Equipment Foundations
- Civil works related to Dust Extraction System and Bunker Ventilation System.
- Civil Works related to Stock Pile Wind Barriers.
- Civil Works related to Dust Suppression System
- Foundations for Stacker and Re-claimers, Coal stock pile run off

drains, fencing, roads, security tower, along with associated items etc.

Ash Handling System and its related Auxiliaries

- Compressor House and Main control room
- Ash Handling System Switchgear Room and RIO Room
- Ash water transfer pump house including sump,
- Silo utility building cum HCSD Pump House including sump including switch gear and control room. Dust Conditioner Sump.
- Structural Steel Water Impounded Bottom Ash Hoppers
- Structural Steel BA overflow tanks in Bottom ash Hopper area
- Structural steel tank for collection of Duct & APH ash hoppers
- Ash water Pump House Including sump
- RCC Fly Ash Silo Six (6) Nos. for 3 units.
- Structural Steel dewatering Bins
- Structural Steel Common Sedimentation tank and common surge tank
- Structural Steel Buffer Hopper Tower (Dry ash Collection Tower) for Fly Ash
- Structural steel Agitator Retention Tank (ART)
- Conveyor belt gallery for transferring moist bottom & coarse ash from dewatering bin to Agitator Retention Tank through clinker crusher
- RCC Pedestals for HCSD slurry disposal pipelines from the HCSD pump house to ash dyke including garlanding in proposed ash dyke (Ash dyke is in Owners scope - Refer Clause 4.36.00 for Terminal points) and RCC pedestals for HCSD slurry disposal lines from HCSD pump house upto mine void area (excluding the portion over Bhedan river bridge and approach ramp). Thrust blocks on both edges as per design requirement shall be provided by contractor, as mentioned elsewhere
- All Civil and Structural Works related to Pipe racks for all Ash related Pipe Lines, Air Pipe Lines, Water Pipe Lines, Misc. drain Sump, Cable racks, Cable Trenches and supporting structures ,and Inspection cum Approach road (4 M wide BT road with drains) from plant to Mine void / ash dyke along Ash Pipeline as mentioned elsewhere.
- Area grading for Inspection cum approach roads up to drain is in the scope of contractor.
- Equipment Foundations.
- Construction of drain sumps in BAH Area, Silo Area and Vaccum Pump Area.
- Weighbridge

- Ash water recovery system from the ash dyke to sedimentation tank at silo area
- Civil & structural works for Biomass Handling System and its related Auxiliaries as mentioned in the relevant Mechanical volume.

Raw Water Reservoir & Transfer System

- Raw Water Transfer pump house & Switchgear Room
- Raw Water Reservoir (two compartments) Storage capacity as mentioned in Mechanical volume.
- All Civil and Structural Works related to laying of raw water intake pipe lines from terminal point near reservoir to plant raw water reservoir and then up to Raw water pre-treatment plant (Refer Clause 4.36.00 for Terminal points)
- Equipment Foundations

Water Pre-treatment & DM Water System

- Stilling chamber, Clarifiers, inlet channels etc. along with associated facilities for Pre-Treatment Plant and DM Plant
- Filter Water Storage Tank
- Chemical House with Treatment Plant/ Lab
- Degasser Tower, Degassed water storage tank & pump house
- DM plant building with switchgear room, control room
- DM Water Storage Tanks
- Acid / Alkali Storage Tanks
- Clarified Water Reservoirs (two compartments) and pump houses with SWGR/MCC Room for PT and DM Plant
- Equipment Foundations
- Sludge Pit & Neutralization Pit as per system requirement
- Rain water harvesting Pond
- Pump House for Rain Water Harvesting Pond.
- PW Chlorination plant building
- UF pump house

Circulating Water System

- CW pump house With Switchgear Room and RIO room
- CW Treatment cum Chlorination plant building

- Equipment Foundations
- All related Civil and Structural Works for valve chambers, Sump, Forebay, Channels from Cooling Tower

Induced Draught Cooling Tower

- All Civil and structural works for RCC Induced Draft Cooling Tower
- Cold water Basin and associated civil works.
Other auxiliaries, stairs etc
- Unitized Switchgear Room

Effluent Treatment Plant

- ETP building including pump house and control & Switchgear room
- ETP CTBD / RO plant building with effluent disposal system
- Central Monitoring Basin
- Clear water tank (and Degassed storage tanks)
- TPI Overflow Sump
- Slop Oil Tanks
- Acid/alkali dosing tanks
- Degasser Tower
- Sumps for respective pumps
- ETP reject treatment plant building
- Equipment Foundations

Sewage Treatment Plant (2 Nos.)

- STP building (2 Nos.)
- All Civil Works related to Sewage Conveying and disposal System including Cast in situ RCC Manholes / Inspection / collection chambers / Ventilating shaft with chambers all of RCC / NP3 RCC Hume pipe laying

HVAC SYSTEM:

- All civil works for air conditioning system

Single-Flue and Bi-Flue RCC Chimney

- All Civil and structural works for one single flue and one Bi -Flue. RCC Chimney with internally lined (borosilicate) steel flue enclosed by RCC

Wind Shield to suit MoEF&CC norms.

- Other Auxiliaries, Internal Steel Platforms, ladders, elevator etc.
- Structural steel staircase upto the top most internal platform and from there to roof of the chimney is cage ladder.

- Two (2) nos. Rack & Pinion Elevator. one No. for each chimney

Fire Protection & Detection System

- Fire Water Pump House
- Fire Water Booster Pump House
- All related civil works for Fire detection and protection for laying fire hydrant lines within the entire plant zone including BTG Area, transformer yard area etc.
- Equipment Foundations

Switch Yard

- GIS Control Room
- GIS Building as per Electrical Requirement
- Transformers Foundation & Reactors Foundations
- Equipment Foundation
- Tower foundations
- GIB
- Storm Water Drainage System
- Burnt oil pits
- Rail Road

Hydrogen Generation plant

- Hydrogen Generation building with cylinder storage facility

Roof Top Solar System

- Civil works for roof top solar system for the RCC Roof buildings inside the entire power station including Thermal Project site office as per the electrical requirement.

General Plant Illumination

- All Civil and Structural Works related to General Plant Illumination System.

Non Plant buildings under this scope of work:

- Canteen
- Fire Station
- Weigh-bridge (three numbers)
- Workshop
- First Aid Centre
- Permanent Stores
- Construction Store
- One no. Toilet Block for CHS area and One no. for Boiler area
- Cycle / Scooter stand and Car Parking Shed near Service Building
- Safety office cum stores

FGD and its related Auxiliaries

Limestone based process shall be adopted for FGD system. The buildings / structures envisaged are listed below.

Limestone Based System

- Limestone Storage Building/Covered structural steel shed
- Limestone Crusher House
- Limestone Grinding Building
- Absorber Pump & Oxidation air blower House
- Electrical Switchgear & Control Building (FGD main building)
- Gypsum De-watering House
- Gypsum Storage Building/shed
- Junction Tower (If applicable)

All Civil & Structural works for the followings are also to be provided:

- Foundation for FGD Absorber System
- Limestone Handling System and Gypsum Handling System.
- Buildings, silos, equipment foundations, sumps, tanks etc.
- Conveyor gallery, trestle as necessary to provide to meet the functional requirements

- Junction towers
- Foundations of all technological structures and equipment like Ball Mill foundation, Miscellaneous Tank and Pump foundations.
- Pipe racks, Cable racks and related supporting structures (as applicable)
- Exhaust flue gas duct structure support foundation.
- Waste water treatment system and related equipment foundations.
- TG, ID & FD fans, TDBFP and MDBFP foundations shall be as per manufacturer's proven practice. Crushers for both Coal and Limestone shall be on VIS
- Transformer foundations including fencing, paving etc.

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the Power Plant and as per system requirement shall be within this scope of work of the contractor. All related approach roads and roads within the system requirement along with RCC drains and sewage network.

Rain water harvesting for the entire Power plant:

All the rain water from road drains/buildings shall be conveyed and let into Rain harvesting pond located at suitable location which is also in the scope of the contractor. In case, if the initial construction water pond is converted into rainwater harvesting pond at a later stage, all the requirements as mentioned below for rainwater harvesting pond shall be ensured.

Inside and bottom surface of rain water harvesting pond shall be lined with impermeable LDPE lining of thickness 1000 micron with overlap distance of 0.5M and jointing of LDPE lining with robotic 2 stitch welding, to prevent loss of water due to seepage. The liner shall be placed over minimum 50 mm fine sand. The liner shall be protected by M30 precast concrete tiles placed over it. Dimensions of precast concrete tiles laid over LDPE sheet will be 300 x 300 x 50 mm – laid over 25 mm thick 1:4 cement mortar. The jointing between tiles should be done with 1:3 cement mortar.

Water from rain water harvesting pond shall be recycled to raw water reservoir. Water from the RWHP will be 100% recycled in the raw water reservoir during normal season. The pond will be located at the lowest contour of the plant as far as feasible so that it can effectively collect all the rain water by gravity.

From the outlet of rain water harvesting pond, water will be pumped out to raw water system for use as supplement to raw water.

Trapezoidal section shall be provided for pond with minimum holding capacity of 40,000 m³ of water below the lowest invert level of the incoming drain.

All necessary system installation for conveying water from RWHP to RWR is within the scope of Contractor.

Plant main storm water network is under Contractor's scope. The entire plant storm water shall be connected to Rain water harvesting pond. During normal operating condition, rain water harvesting pond water shall be pumped to Raw water reservoir through Rain water harvesting pump. During heavy monsoon, water shall be pumped into Bhedan River as per Mechanical specification. Pump house for rain water harvesting pond shall be provided as per system requirement as specified elsewhere.

All civil works related with laying of pipes, specials and supports are under contractor scope. At road crossing RCC box culvert shall be provided for Pipes. RCC box culvert for pipe crossing at top of bund, 150mm thick RCC apron with RCC wall having height equal to height of RCC Box culvert with RCC stepped slab on the outer face of the embankment (River side) shall be provided by the contractor. 150mm thick RCC protection slab shall be provided at bottom of pipe having width of pipe dia +300mm on both sides of pipes over plant side embankment.

Also over flow arrangement for Rain water harvesting pond shall be provided and Invert level of Overflow drain in the Pond shall be 100mm below the lowest Invert level of Inlet drain of the Harvesting pond. RCC drain shall be provided from harvesting pond, crossing the peripheral road outside the compound wall and terminated at 20m from outside edge of peripheral road to discharge surplus/ unwanted storm water of the plant to outside the Plant boundary. RCC box Culvert shall be provided for all Road crossing. MS grill with 16mm steel Rod mesh shall be provided at Compound wall crossing Scheme for the rain water harvesting as above shall be submitted by the contractor for approval by the Owner/consultant.

Pump House for Rain Water Harvesting Pond:

Rain water Harvesting Pump House shall be single storied RCC framed structure with RCC Roof and side cladding shall be of Fly ash Bricks. All necessary provisions to be made to support pumps, gates, screens and other misc. equipment as per system requirement. The operating floor shall be of RCC Floor supported on RCC column / Sump Walls. RCC raft with Sump shall be provided as per system requirement. The superstructure shall have gantry girder for EOT Hoist of capacity as specified in Mech volume. Electrically operated MS rolling Shutter shall be provided towards approach road side. Doors, windows and toilets shall be as per architectural specifications and technical rule. Necessary PVC service/potable water tank shall be provided on roof. Approach to roof through RCC staircase shall be provided. Substructure shall be designed as cracked section. Separate RCC Electrical room/PLC room as applicable shall be provided as per system

requirement. PLC room with false ceiling as applicable shall be provided. Door, Window and other finishes shall comply with Architectural specification. Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Pumps sump shall be designed as 0.1 mm (tightness class 3) section in accordance with IS: 3370 (Latest Revision) by limit state method. If there is an intake fore-bay at the entry of the pump house, the angle of inclination of the side walls of the fore bay with the direction of water flow shall not exceed HIS standards. PRV / sandwich slab for fore bay is permitted.

Pump House for outside plant storm water (2 no's) :

Pump house of suitable size shall be provided with RCC columns, RCC operating floor slab (as per system requirement) and roof shall be of steel truss with galvalume sheet and side cladding. Electrically operated rolling shutter of suitable size shall be provided for pump house (or) open structure with RCC column and monorail supporting arrangement as per system requirement. For Open/ closed pump house. The MCC room shall be provided with RCC roof and RCC columns. Walls for MCC room shall be provided with fly ash bricks. FFL for MCC room shall be +202.5 m. Minimum RCC grade shall be M25. For handling of the equipments in the pump house, necessary mono rail arrangement with hoists of suitable capacity of suitable capacity to handle the single heaviest equipments in pump chamber with 20% margin and to suit the layout condition.

Pumps sump shall be designed as 0.1 mm (tightness class 3) section in accordance with IS: 3370 (Latest Revision) by limit state method.

If there is an intake fore-bay at the entry of the pump house, the angle of inclination of the side walls of the fore bay with the direction of water flow shall not exceed HIS standards. PRV / sandwich slab for fore bay is permitted. RCC box culvert for pipe crossing at top of bund, 150mm thick RCC apron with RCC wall having height equal to height of RCC Box culvert with RCC stepped slab on the outer face (River side) of the embankment shall be provided by the contractor. 150mm thick RCC protection slab shall be provided at all bottom of pipes having width of pipe dia +300mm on both sides of pipes along the plant side embankment.

Approach road: Further, necessary BT single lane approach road at +201 m level from nearest project road to all storm water pump houses and MCC rooms is in the scope of Contractor. Grading and leveling for approach road and at pump house area/MCC room shall be at +201 m level. Necessary approach ramp shall be provided to pump house/MCC room floor from Road

Other Civil Works.

All civil and Structural Works related to Pipe racks, Cable racks, Cable Trenches, Duct banks etc. and supporting structures as applicable for the entire plant area shall be within this scope of work.

All civil and Structural Works related to Roads, drains and Pavements as applicable for the entire plant area shall be within this scope of work.

Wherever plant road meets the plant main road, RCC box culvert shall be provided by contractor. All the storm water drains inside the power plant shall be RCC.

All plumbing and water supply fittings & fixtures, rainwater drainage of plants of any building / premises / open area in the scope of this package. All the sewerage shall be collected from plant area and the same shall be interconnected to the Main Plant Sewer System as per detailed layout requirement which is also under contractor's scope. All drainage and sewage manholes and chambers shall be of RCC of grade M30.

Criteria for Chimney have been mentioned in different sections.

TG, ID, PA & FD fans, TDBFP and MDBFP foundations shall be as per manufacturer's proven practice. Crushers for both Coal and Limestone shall be on VIS.

4.00.00 MAJOR PLANT STRUCTURES / UTILITIES /COMPONENTS

The descriptions of some of the major structures / utilities / components covered under the Package are given below:

The Building dimensions mentioned elsewhere in the Specifications / Contract drawings are minimum requirements only. Dimension of the building shall be decided by the contractor to suit the equipment size to be supplied for functional requirements duly taking into account for maintenance requirements also. Layout shall be prepared by the contractor such that no horizontal overlapping of foundations (at different levels) is encountered to the extent possible. Moreover, combining foundations for different buildings / structures / facilities are to be avoided to the extent possible.

4.01.00 Bunker Building

The entire coal bunker structure complete with motor operated shut off gate at bunker outlet, bunker extraction feeders, coal pulverizes, Coal pipes, pulverized fuel burners and associated auxiliaries. The bunker bay arrangements shall be as per system requirements as specified in the relevant Mechanical Volume.

The entire assembly of the feeder parts, the bearings, driving and driven sprockets etc. shall be housed on heavy duty structural frame with arrangement for mounting the same on RCC foundation.

Walkways, platforms and staircases for the buildings and structures under civil scope shall be provided in accordance with following clear width requirements:

- i) Maintenance access walk-ways: 1500mm.
- ii) Other walk ways: 1000mm.

- iii) Ladders: 600mm. & Staircase: 1500mm for indoor and 1200mm for outdoor stairs (for both steel and RCC)

Handrails shall be provided on all sides of Feeder floor and openings.

Bunker building shall be designed considering load from connecting conveyor gallery and other CHP facilities. The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction.

6 m minimum clear height to be considered above bunker top to accommodate coal feeding arrangement. Also, loading due to dust extract equipment and conveyor to be considered while designing bunker building.

The associated civil and structural works required for the conveyor system as per technological requirement shall be carried out by contractor. In bunker bays, Monorails with Hoists shall be supplied by contractor. The erection and fixing of the same shall also be by contractor.

Supply and erection of all gratings, insert plates etc. shall be under the scope of Contractor. Contractor shall also furnish the required size of insert plate. Contractor shall consider in design and provide necessary embedded plates, inserts, opening etc. in Bunker building bay for installation of bunker conveyor, dust extraction equipment associated accessories.

Connecting conveyor gallery and other CHP facilities at bunker building shall be considered for design of steel superstructure and substructure as required.

Provision of foundations for the interconnecting stretch of conveyor gallery structure between the bunker buildings shall be considered in line with layout and arrangements.

Necessary Expansion gaps as per the design requirement shall be provided at all elevations including roof as required. RCC pedestals for steel columns at this location shall have expansion gap with common foundation.

Bunker Building, In addition to the above, framing arrangement for structural steel platform at various levels, around the bunker shall be provided with proper access steps/ ladder, for needle, isolation gates, for bunker emptying chute approach and poking. Interconnection facility amongst various units at the appropriate level in the bunker floor and other floors in Bunker building as per Mechanical requirement is also in the scope of the contractor.

Roof shall be given access through boiler staircase and elevators. Two nos. of staircase shall provide access to all floor/platforms extending upto the roof level. The bunker building shall be isolated from Power house building and Requisite nos. of all weather corridor as per operational requirements shall be provided to access steam generator building from bunker building. The all weather corridor shall have fixed at one end and sliding supports at other end.

Necessary AI doors, AI windows, Aluminium louvers facing above bunker level etc. (as per HVAC requirements) shall be provided as required. All

windows shall be provided with wired glass as per the requirement.

DI Rain water down-comers for plant buildings and UPVC down comers for non-plant buildings shall be provided as per the requirement.

Erection openings as required shall be provided complete with removable hand railings, hatch covers etc.

Roof water proofing shall be as per technical specification mentioned elsewhere in this contract.

Building roof shall be of Cast-in-situ R.C.C. over galvanized MS metal decking (colour coated on exposed surfaces) of approved profile supported on steel beams/girders and the sides shall be cladded with permanent colour coated metal cladding system with double skin with insulation. The cladding shall be from Bunker feeding floor to roof. The remaining portion of the building below Bunker feeding floor up to ground floor shall generally be uncladded. However, brick cladding shall have to be provided, if required, as per TAC and any other statutory requirements. All the cladding and roofing sheets shall be of Zincalume.

The Bunker building Columns and auxiliary columns, etc shall be designed/spaced accordingly and also for convenient operation/maintenance of Mills and other equipments.

4.02.00

ESP Control Building

ESP Control Building will be a RCC framed building. This shall be one number per unit. This unitized building is located adjacent to ESP for respective unit. All electrical Switchgear & Control panels for ESP operation are located in different floors of this four-storied building, having one floor allocated for accommodating Switchgear, one for Auxiliary control panels(ACP) and HVAC equipment and balance two for cable spreader below switchgear and ACPs.

- i) Lift shall be provided besides other facilities.
- ii) RCC foundations shall be provided for the building structures.
- iii) Necessary glazing shall be provided on the wall of the control room to have a good view of the operating areas. False ceiling shall be provided for control room.
- iv) All trenches, pits, channels etc. shall be constructed of water tight reinforced concrete.
- v) RCC roof slab shall be rendered water proof & shall have DI rainwater down comers as required.
- vi) Ground floor slab shall be RCC floor with subgrade as per Technical

Rule.

- vii) False ceiling, Partition etc. shall be as per architectural/technical rule.
- viii) RCC staircase with hand railing shall be provided as per architectural/Technical rule.
- ix) Necessary arrangement shall be provided for lifting the panels.
- x) Doors, windows, ventilators etc. shall be provided to suit requirements as per Architectural/Technical Rule.
- xi) Inserts and cut outs shall be provided to suit requirement.
- xii) Finishes, fittings and fixtures shall be provided as per architectural/Technical Rule.
- xiii) PCC apron shall be provided in slope all-round the building with side drains.
- xiv) Chain link fencing around the transformers and gate as required shall be provided.
- xv) Suitable access road shall be provided to the building.

4.03.00

Auxiliary Boiler MCC & Control Building

Auxiliary Boiler MCC & Control Building will be a RCC framed building with RCC roof. It shall have two rooms, one for accommodating the electrical MCC & Panels for Auxiliary boiler while the other shall be meant for accommodating DDCIMS remote I/O cabinets and operator stations. Auxiliary boiler shall be covered with rain canopy made of steel frames, supports, steel sheeting, etc. complete.

4.04.00

Fuel Oil Unloading cum Pressurizing Pump house

The Fuel Oil Unloading-Cum- Pressurizing Pump House shall be RCC building and is common for all the units. This building is located near Common Fuel oil dyke area (The number of pumps shall be finalized as per the technological requirement)

Sumps/collection pits shall be provided with drainage facilities for underground channels/pits etc.

Inserts and cutouts shall be provided to suit requirement.

RCC roof slab shall be rendered waterproof with adequate waterproofing treatment and shall be provided with DI down comers.

Doors, windows, rolling shutters, ventilators etc. shall be provided as per

requirement.

Necessary glazing shall be provided on the wall of control room to have a good view of the operating area.

PCC apron shall be provided in slope all-round the building with side drain.

Suitable access road shall be provided to the building.

Civil works to facilitate erection of monorail.

Switchgear & Control room

Fuel Oil Storage Tanks

- i) Suitable foundations for required number of tanks shall be provided.
- ii) RCC bund wall / dyke of required height shall be provided all-round in the tanks area to contain oil spills and any leakage and in accordance with Government Acts & regulations on oil pollution prevention.
- iii) RCC paving shall be provided in the tank area outside tank foundation with slope towards RCC peripheral drain. RCC crossovers shall be provided at appropriate locations for entry of personnel to the tank farm.
- iv) Pits, trenches etc. shall be of RCC construction with adequate water proofing treatment.
- v) RCC foundation for all auxiliary equipment, all pipe line supporting trestles, pumps etc. shall be provided as per requirement.
- vi) Chain Link fencing shall be provided all-round the area with provision of steel gates and access road as per LPA norms.

4.05.00 **Not Used**

4.06.00 **Compressor Shed in Ammonia Storage Area**

The Compressor Shed in Ammonia Storage Area shall be located as per plot plan.

The shed is of structural steel construction with sheet roofing and the sides are open.

- i) Reinforced concrete foundation shall be provided for building columns.
- ii) Reinforced concrete foundations will be provided for all equipment at ground floor.

- iii) The ground floor slab shall be of RCC as per architectural / technical rule.
- iv) Finishes, fittings and fixtures shall be provided as per requirements.
- v) Suitable access road shall be provided to the building.

4.07.00 **Electrical Room for SCR System**

The number and location of Electrical Room for SCR System shall be as per electrical requirement. It will be a RCC framed building with RCC roof.

4.08.00 **RIO-cum-VFD Panel Room**

3 (Three) numbers (1 for each unit) RIO-cum-VFD Panel room to be provided near boiler area. This building to be single storied Steel-framed building with RCC foundation. To be clad by Fly ash brick walls. Roof shall be of RCC on metal deck. The room shall be air conditioned with false ceiling. RCC Grade slab to be as per Technical Specification. All related civil works are under scope of contractor.

4.08.01 **Boiler Maintenance Building**

The Building is to be sized and designed to meet all functional requirements including crane handling as per mechanical requirement (minimum size 30m x 60m). Minimum clear Height of Boiler Maintenance building shall be 8.0 M (Minimum) where ever crane movement is envisaged or more depending upon mechanical functional requirements. The building shall also house the various facilities such as Store keeper room, staff room, Maintenance engineer room. Toilet shall be kept far away from the location of the movement of people & the office space. Store shall have two numbers of facilities for rack room of minimum size 14 M x 22M and 14 M x 8 M within the said building. Rack room shall have requisite number of cast in situ racks along the outer periphery wall.

This building shall be single storey steel structure of framed / braced design. Roof shall be RCC over metal deck on structural steel beam. Crane Supporting Structures shall be provided including Supply and Erection of EOT Crane of capacity as per the Technological Requirement. Side Cladding shall be of Fly ash brick.

RCC ground floor slab shall be provided as per architectural/technical rule.

PCC apron will be provided in slope all around the building with side drains.

Steel door and aluminium glazed windows with steel grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

Toilets are to be provided in the building as per the technical rule. 150mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided

4.09.00 **Power House Building**

4.09.01 Turbine Building

The turbine building is an enclosed insulated, weather-tight steel framed structure which houses the turbine generator, condenser and related equipment including the feed water heaters. For sizes and levels of TG building, refer relevant sections of Mechanical specification volume.

Access shall be provided to the unloading and maintenance bay for unloading TG components and auxiliary components. The superstructure shall be of structural steel framing with RCC floor slabs on permanent color coated metal deck sheeting. Fly Ash Brick work side cladding upto 3.0m from FFL and above that double skinned insulated zincalume metal sheet cladding upto roof level to be considered for 'A' row and gable ends. At B row, fly ash brick cladding shall be above deaerator floor.

On C Row, it shall be completely of fly ash brick cladding.

Polycarbonate sheets shall be fixed along with metal cladding in approved pattern/as shown in the contract Drawing for adequate lighting purpose for the Power House Building.

The roof of the TG bay shall be permanent metal decking with in-situ concreting and screed on top and supported on steel truss. The structure is braced in the direction of the crane travel but provided with rigid joints at roof level and framing at other floor levels with the electrical and mill bays in the transverse direction. The roof of the TG Bldg shall have Electro mechanical roof extractor.

Service and maintenance bays shall not have any intermediate floors, however a 1500 mm wide observation gallery with handrails shall be given along the wall at the operating floor level to observe the TG erection operation.

The access to the roof of the TG building will be provided with staircase. Adequate number of Windows shall be provided to ensure natural light.

Doors on external walls shall be provided as per the functional requirement as well as considering emergency escape provisions. For equipment entry into the service bay specially designed steel electrically operated rolling shutters shall be provided with appropriate operating mechanism. Electrically operated rolling shutter shall also be provided in front of condenser to facilitate tube removal.

Rain water from the roof shall be taken into DI rainwater pipes at suitable intervals as per architectural / technical rule. DI pipe sleeves for draining out

rainwater from chajja and canopy shall be provided at suitable locations.

Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.

AC Plant shall be located in the ground floor of common control building.

Pipe rack between C-D row shall be provided. CD bay pipe rack may be connected with turbine building / boiler column with PTFE connection. Accordingly the loadings shall be considered on the Boiler and TG building design with required margin.

TG hall EOT crane capacity shall be as per mechanical requirement.. For rigging and positioning of the condensers, building frame shall not be of any hindrance and temporary openings in the building walls and wall supporting structures shall be maintained till completion of the rigging and positioning of the condensers.

Within the building, the concrete foundation for supporting the turbine generator shall be completely isolated from the building floors for vibration control. The foundation for Turbo-generator shall rest on suitable vibration isolation system consisting of springs and visco dampers (supplied by owner approved vendor).

The Boiler Feed Pumps / motors are erected either on elevated floor or on ground floor, foundations for the same shall have suitable vibration isolation system consisting of springs.

The fundamental frequency of the foundation shall be at least $\pm 30\%$ away from operating frequency. Resonance at other possible frequencies (half and twice operating speed) shall also be checked.

RCC plinth beams shall be provided connecting the RCC columns/pedestals along A, B, C rows and Gable ends.

The concrete operating floor shall be designed for construction and maintenance loadings of TG. Hatchways with removable chequered plates or grating floor covers shall provide access to equipment on lower floor and shall be within turbine hall crane access. The intermediate floors shall be of concrete with hatchways as necessary.

The fasteners to be used for these factory made panels shall be of adequate sizes, self-drilling and self-tapping type, compatible with galvalume steel sheets.

Windows, doors, exterior walls, internal finish and external finish shall be as laid down in Vol: II-G/1, section-IV of this specification.

The roof shall be flat with a gentle slope of about 1 in 100 towards the transformer yard. The roofing shall be done by cast-in- situ RCC slab over

metal decking supported by steel purlins which are spanning between two adjacent roof trusses. The roof shall be insulated by providing 75 mm thick foam concrete. The roof shall be provided with membrane water proofing as per architectural specification for making the roof waterproofed. Roof finishes shall be as per architectural specification mentioned Vol:II-G/1,section-IV of this specification.

Lighting, ventilation shall be provided as described in other sections of this specification.

i. Electrical and Deaerator Bay

This bay is continuous with the turbine building on the boiler side. This bay houses the electrical switchgears, deaerator heaters, control panels and provides space for major pipe lines and electrical cables.

All floors with hatchways as required & roof shall be of cast-in- situ concrete and the sides shall be cladded with 230 mm thick fly ash brick masonry. Deaerator floor shall be properly sloped for draining water to nearby catch pits or drains.

Stairs and platforms shall be provided as required for maximum utility and safety.

All floors and roofs of Turbine Hall shall be cast-in-situ RCC slab over metal deck as mentioned above.

RCC slab-on-grade on ground floor shall be laid as per architectural / technical rule Ground floor slab shall have drainage trenches covered with steel grating.

Stairs and platforms shall be provided as required for maximum utility and safety. Stairs shall have to be provided as per TAC / LPA regulations and any other statutory requirements.

Expansion gap of 50 mm shall be provided at all elevations between RCC floors and roofs of two adjacent units. At the roof it shall be suitably covered so as to make it leak proof and the floor gaps shall be properly covered so that the smooth access, from one side to other is not prevented. Steel columns of adjacent units at this location shall be 1500 mm apart and shall have common foundation.

The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that in front of control room no cross bracing is provided.

A minimum headroom of 2200 mm shall be given in the cable vaults. In control room false ceiling level shall be kept 3500 mm above floor level.

All floors shall be of in-situ RCC slab provided over structural steel beams with Metal deck sheeting. Minimum thickness of structural concrete shall be with an additional 50 mm provided for finish as per architectural/technical rule. No openings shall be permitted on the roof of control room excepting possible opening for A/C duct to exercise proper control on air conditioning. Any such AC Duct shall be within the AHU room only and no part of it shall be exposed.

No openings shall be permitted on the roof also, as this shall interfere with effective water proofing.

Windows, doors, exterior walls, internal finish and external finish shall be as laid down in Vol: II-G/1, section-IV of this specification.

Walls shall normally be supported on wall/floor beams. If wall beams cannot be avoided they shall preferably be given at the level of floor beams and shall be encased in concrete. No portion of the structural steel column shall be visible inside the room. All such columns shall be encased upto the next roof level with fly ash brick masonry.

Cable vaults shall be provided with minimum 2 doors for each floor. The doors shall be 2-hour rated fire-check doors. No windows shall be provided on the turbine bay side.

Switchgear room shall be provided with minimum two 2-hour rated fire-check doors to satisfy statutory requirement. In addition a two leaf sliding doors of slush welded steel construction may be provided if required to move the switchgears into the room making use of equipment lifting hatch provided in turbine building.

For Control room & Annex rooms, refer to Vol: II-G/1, section-IV of this specification.

Floor above control room, where steam / water pipes are routed, shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room.

All openings in floor for switchgear and other panels shall be sealed with fireproof material after cables are connected.

PCC apron shall be provided in slope all-round the building with side drains. Architectural finishes shall be as per specification described elsewhere. Suitable access road shall be provided for the building.

4.10.00 **Not used.**

4.11.00 **ACW Pump House**

BTG layout having ACW pump house inside / outside of TG building as per proven practice of the Contractor. Three (3) nos ACW Pump house, one for each 800 MW unit, have been envisaged for this project. Necessary hoisting facilities shall be provided as per the mechanical requirement.

For ACW pumps locating outside, a building is envisaged. This shall be a double storied (G+1) steel framed building. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by fly ash brick upto 1.0 m height from FFL supported on plinth beams. Above 1 m high fly ash bricks Double skin sheet insulated Zincalume metal cladding shall be provided Air washer Room is provided in 1st floor. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided for.

4.12.00 CST Pump Shed

This is located in front of A Row of Power house building. One no CST Pump shed has been envisaged for three 800 MW units and the same is located near Unit no I.

This shall be a single storeyed steel framed shed structure with Zicalume roof sheeting and Side Sheeting. RCC Grade slab as per Technical Specification.

4.13.00 Condensate Storage Tank

Three (3) nos Condensate Steel Storage Tank each having capacity as per Mechanical requirement shall be installed near power house. Diameter of Tank shall be around 12 M. All civil works including foundation, paving, drains etc. are under the scope of the contractor.

4.14.00 CPU Regeneration Building

This building is located near Boiler Unit no I. This building is common for three 800 MW units.

This shall be a Three storied (G+2) steel framed building. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by fly ash brick. Proper drainage of the floor has to be provided for. Necessary hoisting facilities shall be provided as per technological requirement.

4.15.00 DG Plant Shed

DG Plant shed is located in Transformer Yard. Four (4) nos DG sets (one for each 800 MW Unit and one common standby for three 800 MW Units) shall be housed in this shed.

This shall be a steel framed shed structure with roof sheeting and Sides are open. RCC Grade slab as per Technical Specification. All related civil works are under scope of contractor.

4.16.00 Plant IA/SA Compressor House

IA/SA Compressor House is a single storeyed Steel-framed building with RCC

Roof. It is located near SG area. Compressor House is clad by Fly ash brick walls. RCC Grade slab as per Technical Specification. All related civil works with facilities are under scope of contractor. Necessary hoisting facilities shall be provided as per the technological requirement.

4.17.00 **Service Building**

This is a five storeyed (G+4) RCC framed structure fully clad with fly ash brickwork. Mainly office zones to be provided with necessary toilets. Floors in the power house shall have access to the Service Building Floor. Two numbers of staircases and Elevators are to be provided inside the building. For detail descriptions, Vol-II-G1-Sec IV (Architectural part) may be referred. The total floor area of the building shall be minimum 7000 sqm. **This building shall accommodate simulator room of minimum 100 sq.m as per technological requirements mentioned elsewhere including battery room.**

4.18.00 **Transformer Yard**

Transformer Yard shall comprise of foundations for transformers mainly GT, ST, UT, and UAT. There shall also have foundations for bus ducts, lightning arrestor etc. In transformer yard area cable shall run in RCC trenches. Foundation for rail track, Jack pad with mooring point shall be provided in yard area. Cable pull pit, Duct bank, Fire walls, Oil collection pit, chain link fencing with gates etc. shall be part of Transformer yard.

Civil works for the equipment foundations, facilities and miscellaneous civil works to be provided for the project shall include but not be limited to the following:

- All Transformers and its foundation including ST, GT, UT, and UAT with soak pit and common oil pit.
- Fire separation/protection walls in RCC (as per LPA norms) for transformers.
- The RCC Paved area for the Transformer yard shall extend from A row columns to Road R39 and Road R16 to R5 covering the entire Transformer yard. The entire transformer yard area shall be provided with chain-link fencing with necessary gates
- Cable trenches in the transformer yard for facilitating laying of cables.
- Cable, pipe trenches and duct banks within the power plant.
- All civil works related to laying of Fire Hydrant lines like trenches/pedestals etc., are in the scope of Contractor.
- Permanent road and its connection to the plant main road and pavements for the various facilities including providing culverts, drains etc, Rail track within the Transformer yard and up to the maintenance bay for movements of Transformers.

- Surface drains are to be connected to nearest storm water drainage system of the plant, which is connected to the plant network.
- For contaminated water / oil drainage, arrangement shall be made to drain the same including effluents from UTs/UATs/STs to sump pits by gravity flow. Also refer Electrical volume Vol-II-F1 in this regard
- Supporting structures and platforms with access for utility pipelines.
- The transformer yard paving shall be 100 mm below the plant 0.00 (i.e.) Power House Bldg Finished ground floor level. However, all the rail roads shall be kept at 0.00 M level. Wherever, the paving approaches the rail road shall be provided with a mild slope to make easy movement of vehicular movement.

4.19.00 Pipe/Cable Trestles and Foundations

All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures wherever erection of trestles is not possible for easy inspection & maintenance within plant area. All the pipe/cable racks falling in the plant area shall be suitably constructed as per the piping / electrical requirements. In some localized area, Pipe/Cable can run in R.C.C. trenches. In case over ground routing is not feasible due to site constraints, the pipe/cable to be routed through duct-banks, subject to the approval of the Owner.

A minimum clearance (clear head room) of 8.0m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In other areas the clear height shall be 4.0m (minimum) from finished grade level. All cable racks shall be provided with continuous walkway of minimum 600 mm width with handrail and toe-guards all along the length of the trestle along with approach ladders near roads, passageways etc. All pipe racks shall be provided with walkway as per the mechanical requirement. Walkway shall be provided with GI Grating. The racks can be multi-tiered. Cable shall normally be laid above the pipes. For actual width of the pipe rack, no. of pipes/cables etc. shall be as per Mechanical specification and drawings may be referred.

Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.0m) etc. up to the pipe/cable rack trestles.

Pipe thrust shall be considered as per layout and design requirements.

Trestles (framed twin columns) & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch (maximum distance shall be 100m) Crossover, operating platform & necessary trussed resisting arrangement at pipe bend shall be provided as required. Necessary expansion joints in the structure shall be provided as per IS: 800 (Latest

Revision). The trestles shall generally be provided using rolled sections only.

4.20.00 Criteria for Facilities / Structures

All the Buildings/ Structures to be constructed as per the process requirements. Different functional requirements like Mechanical, Electrical, C&I, HVAC etc. to be fulfilled while designing the building / facilities sizes and other details. All Codal stipulations shall be maintained.

Architectural requirements shall be as per Vol-II G1/ Sec-IV.

All non-plant buildings which are parts of EPC package are described in detail in Vol-II G1/ Sec-IV.

Other buildings / facilities not specifically mentioned in this section or in Vol: II-G/1, Section-IV, but required for the operation of the plant shall be constructed by the contractor.

The contractor may add extra facilities/buildings as may be required for operation of plant without additional cost to the owner subject to prior approval of Owner/Consultant.

Above list of Buildings mentioned in cl 3.00.00/4.00.00 is minimum and not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work.

4.21.00 Design of infrastructural facilities

4.21.01 Roads

All roads shall be RCC roads except approach roads to Raw Water Reservoir and some of the patrol road along compound wall inside plant boundary as per Plot plan which are BT roads (Refer Clause 4.36.00 for Terminal points).

The sub base over the well compacted subgrade of all plant service roads within plant area shall initially be made with hard shoulder on either side of carriage width as per architectural/technical rule. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement. For RCC roads the construction layers (cross section) as per cl 2.07.00/Vol II-G2/Part A/Section X shall be followed.

All power plant (RCC) roads within plant area shall have rectangular RCC side drain along both sides.

All RCC Roads and parking area shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice and MOST specification (MORT&H) for movement of heavy equipment.

All roads around the plant to FOPHS, boiler area, Turbine area, transformer yard area and where there is heavy vehicle movement shall also be of RC concrete roads with hard RCC shoulder.

All the roads in the entire plant area within the EPC package scope shall be executed by contractor. All roads included in EPC Package as shown in Plot Plan shall be constructed by the contractor as per the basic design and layout.

The additional roads and access to individual buildings/structures/facilities within scope of this specification which are not specifically shown in layout but required from functional requirement is also included in the scope of Contractor. Moreover, contractor to note that all these roads shall be RCC only.

All the roads within the plant shall be under the scope of the contractor including formation of sub-grade, sub-base and laying of DLC, PCC and RCC.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design or 250mm thick whichever is higher shall be laid over 100mm PCC M10 and 100mm DLC on a stone boulder / laterite sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

Minimum RCC carriageway and shoulder width shall be as per approved drawing.

The 'Type' of RCC roads to be decided based on the approved plant and road layouts based on Contract Drawing.

Finished top (crest) of roads shall be 250 mm above the surrounding grade level.

Access within the plant site as well as to building / structures shall be provided as a system of roadwork.

4.21.02 **Surface Treatment**

F.G.L. of Boiler Area shall be 202.500 M.

F.G.L. of Power House Area shall be 202.500 M

Plant 0.00 shall correspond to 203.00 M which is FFL of Powerhouse building. All reference shall be taken from plant 0.00 only.

The Finished Paving Level (FPL) of the Entire Boiler Area shall be 200 mm below the FFL of the Power House Building.

The Finished Paving Level (FPL) of the Entire Transformer Yard Area shall be 100 mm below the FFL of the Power House Building.

The entire Switchyard area shall be provided with chain-link fencing. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size BG metal.

The entire boiler area (from Road R5 to R18 in North-South direction & from R30 to C-row of power house building in East-West direction) shall be provided with RCC Paving.

The entire boiler area and Transformer yard area shall be paved with reinforced cement concrete with 150 mm thickness minimum and sloped to drains.

The RCC paving applicable in the EPC package, Shall be 150 mm thick or as per design requirement whichever is higher and shall be sloped to drains. Paving shall be M30 except road portions with double layer of reinforcement min 10 mm tor 200 c/c both ways (top & bottom) over 100mm thick lean CC M10 on 230 mm thick compacted stone boulder / laterite soling interstices filled with gravel over well-compacted (Minimum 90% Proctor density) Sub-grade.

Maintenance access roads of minimum 7.5m wide shall be provided to all major equipment e.g. ID Fan, FD Fan, ESP etc. All drain / trench covers in these areas shall be designed to withstand truck loading of class IRC.

Roadways shall be clearly identified with kerbs and painting. All drain / trench covers in these areas shall be designed to withstand truck loading as mentioned in Vol II G1/section II.

The drainage of the entire plant area shall be properly planned. Network of RCC drains having RCC cover along with slotted holes and Galvanised MS grills at a spacing of 4m shall be provided covering the entire Boiler, Transformer and Switch yard areas which shall lead the storm as well as process leakage water to the peripheral drains, which in turn shall lead to network of plant RCC storm water drain system with rain water harvesting pond . Other areas (except Boiler, Transformer yard and Switch yard areas) the RCC drains are rectangular Open drains. All structural steel columns in the area shall be provided with encasing to a height of minimum 200 mm above paving level and in addition the bases also need encasing if base plates are below paving level.

4.21.03 Area Grading

Initial site leveling & Area Grading works of the entire plant area, raw water reservoir and all other areas under EPC Package (refer section A) shall be carried out by the Contractor. Also, final micro leveling is to be done by the Contractor as the area may get disturbed due to construction and monsoon activities.

Work shall have to be carried out as per grading layout plan approved by the Owner. All existing drains/channels in the plant and other areas associated with the plant shall be suitably diverted before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding in adjoining areas.

4.21.04

Storm water & Drainage System

RCC rectangular Drains shall be designed as a network covering the entire plant area are under contractor's scope. Plant main storm network is under EPC package. Carrying the storm water of the entire plant to the Rain water harvesting pond and from the pond outfall point upto Bhedan River is within the scope of contractor. It shall be noted by the contractor that buildings area under owner's scope shall also be considered and joined in the main plant storm water system & main plant drainage network. Hence, the contractor shall design their storm water RCC drain & Sewerage network to take the additional load accordingly.

Sewerage from various facilities of the EPC package shall be considered. Overall sewerage system shall be designed accordingly.

All the drains including the Plinth protection drains shall be of RCC within the plant area. All the buildings shall have plinth protection of 1000 mm wide (excluding drain width) towards the peripheral drains.

Auxiliary/Branch drains shall cover individual grades to terrains; collect storm water and other non-contaminated discharge from plant buildings and then to be connected to storm water drainage system.

The invert level of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the drain under all condition. RCC box culverts shall carry drainage under intercepting roads and railway tracks. Suitably designed underground storm water RCC box culverts on the basis of design loads specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view. The drains shall generally be of open type (except Boiler, Transformer and switch yard areas) RCC rectangular construction with 600mm minimum clear width except for building plinth drains which shall be 300mm minimum clear width. All plinth drains shall be covered with Precast slab.

All drains along the periphery of buildings, boiler, transformer and switchyard areas and all plinth drains shall have perforated R.C.C. pre-cast cover slab of minimum 50 mm thickness with provision of openable galvanized steel grating covers at every 4.0 m intervals. Design of such drain covers shall be done considering loading as specified elsewhere. In areas where operational requirements are there and vehicular loads shall come, pre-cast RCC covers/box culverts of suitable thickness without perforations and designed for the vehicular loads (as mentioned in Vol II G1/section II) shall be provided.

The drainage system shall be designed for precipitation intensity of 100 mm per hour (maximum hourly intensity of rainfall). Run-off coefficient for open ground area (unpaved) shall be minimum 0.75 and for paved area and other covered surface including roads the same shall be considered as 0.9. Minimum free board of 150 mm shall be kept while designing drains.

Surface drains shall normally have a slope of not less than 1 in 1000 along

longitudinal direction and RCC structures shall be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box culverts. Minimum self-cleansing velocity shall be adopted as 0.7m/sec but the velocity of flow shall not be more than 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

4.21.05 **Construction Facilities for early works**

The Contractor shall develop and construct all necessary facilities like Batching plant, Construction store, Fabrication yard and Raw material storage area and Canteen for site personnel at no extra cost to the Owner. The associated roads and drains connecting these facilities shall also be constructed by the Contractor. The Contractor shall visit the site and locate suitable areas for these facilities.

4.21.06 **Not Used**

4.21.07 **Waste water Drainage system**

The Boiler area, turbine area and Transformer yard area service water waste shall be collected in a RCC underground oily waste retention pit. Pump supporting floor/maintenance area shall be provided. The contractor shall provide the necessary pumping mechanism and the pipeline upto the Oil Water Separator (Oil Water Separator is also included in the scope) for disposal of the same.

4.22.00 **Coal Handling Plant**

Structures in CHP are discussed below. For detailed specifications of Coal Handling System, Volume II-H2 of this specification shall be referred to. Coal handling areas shall have suitable surface drainage facilities.

4.22.01 **Coal Stock Yard**

Entire area as per mechanical requirement shall be excavated to suitable depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller. 100mm thick river sand cushion layer shall be placed over compacted sub-grade and consolidated by flooding. 230 mm thick boulder soling shall be laid over sand cushion with joints filled with river sand. Over boulder soling, compacted soil with 1:300 grading shall be provided and soil shall be topped by 200 mm mill reject layer/coal sacrificial layer in coal stockyards.

The coal stack area shall be graded with suitable slope for draining the surface by longitudinal drains shall be of RCC trenches with graded gravel packets at about 1.5m intervals on the sides to trap coal dust. Weep holes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal drains for discharging into the main surface drain to be provided by the contractor by the side of the road. RCC retaining wall of 1.0 m height above FFL (Paving) shall be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control

joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stock area shall take care of loads arising due to dozer movement and shall be designed to sustain coal-water pressure.

RCC drains with removable pre-cast RCC slotted cover shall be provided on either side of the coal stock yard and all-round the stock piles. These drains shall be designed to carry the drainage of water during rain from the coal yard and leading to runoff pit. The header drain shall be provided with a bifurcation at the discharge end i.e. at the inlet to the common collecting/settling pond so that it gets divided in to two individual branch drains. Each individual branch drain shall be provided with a gate suitable for operation in coal slurry at the inlet to individual section to the common collecting/settling pond. The slope of the drains shall be so designed for easy run-off.

Coal yard run off pit / settling tank shall be of RCC construction with baffle walls to facilitate settlement of coal particles in the pit. The tank shall be in two compartments separated by a partition. A sump shall be provided at the end of the pit to pump out the decanted water. The clear water from the tank shall overflow into an adjoining settled water tank compartment and the clear water shall be pumped to the clarifier. Necessary platforms shall be provided for Pumps. The coal Pile run off system shall be designed in line with guidelines given in mechanical Volume II-H2.

RCC approach road to the coal stock yard shall be provided by the contractor Approach Road to nearest road and other roads inside stock yard with RCC drains and RCC box culverts shall be suitably provided. Roads shall be 7.5m wide with berm of 1.5m wide on both side and shall be of RCC.

Stacker cum Reclaimer foundation shall be in RCC and shall be designed as a Frame / continuous wall supporting the rail and the wall shall be resting on rigid type RCC continuous strip foundation. Lateral tie beams between two rail supporting elements shall be provided at a regular interval of approx. 3.0m center. The conveyor shall be supported on lateral tie beams connecting the rail supporting structures. Expansion joint for the beams supporting the rails preferably at 30m is to be provided. No expansion joint is permitted in foundation. The foundation shall be designed for the most critical combination of loads as furnished by the equipment supplier. The portion between the two rails and between rail & retaining wall on both sides shall be paved in concrete as per specification.

Water supply points shall be provided at suitable intervals along the stacker and reclaimer rail track as per mechanical requirement.. Beyond stock pile area and up to the junction Towers, foundations for trestles, short supports shall be given. The top of pedestals shall be 500mm above FGL.

RCC supports for Dust Suppression System in stock yard shall be provided by the contractor. The RCC structures shall be designed in accordance with design criteria.

All civil and structural works for Wind shield in the stock pile area shall be

provided as per mechanical requirement.

The following specifications shall be followed for wind barrier.

- 1). Height of the wind barrier is about 3m over above the stockpile height. Note in the plot plan corrigendum will be modified accordingly.
- 2). Wind barrier shall be provided for all four sides of stockpiles as per the corrigendum issued in the plot plan.
- 3). MOC of wind barrier: HDPE mesh shall be knitted high strength made of HDPE monofilament knitted UV wind screen mesh of high strength with 70% block four holes per inch length wise and three holes per inch width wise.
- 4). All necessary civil & structural works, other utilities for wind barrier shall be in the contractor scope.

Refer to Vol-II-H2 for detailed mechanical and process requirements.

4.22.02 Junction Towers (JTs)

Over ground JTs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The super structure for JTs shall be of steel framed structure with adequate bracing arrangement. The ground floor shall be of RCC and shall be finished with cement concrete flooring with metallic hardener having proper slopes for drainage. All intermediate floors shall be of RCC over metal deck. The roofs shall be of metal deck with RCC slab with water proof treatment and drainage slope. The side cladding shall be of single skin, zincalume metal cladding.

JTs shall be provided with independent steel staircase with steps of Galvanised MS grating from ground to Roof level. Elevator shall be provided as per mechanical requirement. The elevators shall be provided with elevator pit at the ground level and MCC room at the top. The clear width of the stair , tread and rise shall be as per architectural / technical requirement. However the codal regulations shall also be complied with. Continuous galvanized MS handrails shall be provided for the staircases.

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All Junction Towers shall be provided with adequate number of windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside /outside of Junction Towers may have chequered plate floors with horizontal floor bracing.

Minimum clearance of 1.5 m shall always be provided around any equipment / structure / pedestal inside the building.

Junction Towers with metal sheeting as cladding shall have 1.0 m high 230 mm Fly ash brick enclosure from finished ground floor. Around the building. Fly Ash Brick wall shall be inside face of sheeting with a lapping of 150 mm. Adequate floor washing arrangement shall be made for all JTs. Provision of

floor dust collection and removal by chute shall be made. The wash water shall be collected in the covered settling pit and covered clear water over flow pit at the ground level. The clear water will be send to the nearest storm water drain. These pits shall have enough volume for one time floor wash with retention time of 30 min. The same is applicable to all the buildings / structures in CHP including Conveyor Gallery.

Deflection of JTs at conveyor entry level shall be within height/1000 across the conveyor & height/500 along the conveyor. While designing JTs necessary provision shall be made in loading for future conveyor to house inside JTs (JT8). Minimum height between the floors in junction towers shall be 4m. Sliding door shall be provided at the monorail openings. Removable Handrails shall also be provided at these locations. Monorail projection outside the building shall be as per system requirements. RCC paving 5m width upto Road shall be provided at the unloading area (GL).

Door, Window and other finishes shall comply with Architectural specification. Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided.

4.22.03

Conveyor gallery and Trestles

On grade and over ground galleries shall be of enclosed type for adequate weather protection. The walkways for on-grade galleries shall be raised and they shall be made of concrete with skid proof finish. Overhead conveyor galleries shall be structural steel consisting of two girders braced at top and bottom and supported on trestles.

Walkway portion of over ground conveyor galleries shall be of chequered plate of 8mm thick with antiskid bar or expanded metal grating. Minimum clear width of central walkways shall be as 1100 mm and side walkways shall be 1000 mm with 3.0 m clear height. For Single Conveyor gallery, both side Walkways shall have 1000 mm minimum clear width. The maximum span of standard gallery shall be 24 m unless higher span is necessitated due to site constraints which shall be subjected to the approval of Owner/Consultant. The galleries for double stream conveyors shall have one central walkway and two side walkways and single stream conveyors shall have two side walkways.

Galvanised MS Hand railings shall be provided as required. For Entire conveyor Gallery seal plate of minimum 4 mm thickness shall be provided so that a complete leak proof bottom will be formed. The over ground conveyor galleries shall be designed for adequate ventilation and natural lighting.

Conveyor gallery having slopes greater than 8 degree, stepped walkways of chequered plates with nosing and toe guard shall be provided all along the conveyor. 10mm dia Tor anti-skid steel bars shall be provided @ 500 mm c/c for inclined walkways below 8 degrees.

Suitable floor washing arrangement shall be made in the conveyor gallery

with down comers.

In between Junction Towers / buildings four legged trestles shall be placed at a maximum interval of 100 m. The arrangement shall be such as to ensure that force in the longitudinal direction of conveyor gallery of length not more than 100 m shall be transferred to four legged trestle. Cross overs shall be placed for conveyors at approximately every 100m of route length and minimum 1 per conveyor. For conveyors more than 40 m length automatic counter weight gravity type Automatic take up with HGTU or VGTU (complete system) shall be provided.

Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and movement.

End of conveyor gallery which shall be supported over Junction Towers, shall be so detailed that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to Junction Towers and vice-versa by providing sliding supports.

All RCC trestle pedestals shall be raised to minimum (+) 0.500 m above FGL. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels, trenches, drains, etc. The minimum clearance over road and railway crossing shall be 8.0 meters.

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girder shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans.

Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position.

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

Conveyor gallery shall have permanently colour coated Zinalume sheet covers on roof and both sides. However in roof, a panel of minimum 1.5mx1.5m area at about 6.0m c/c shall be provided with 4mm thick translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof

sheeting. The bottom level of edge of roof sheeting shall match with bottom of slit level to prevent rain water entry. Adequate provision of openable aluminum windows shall be kept on both sides of conveyor gallery with MS safety grills inside.

Crossover with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 m intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

Conveyor gallery structure shall be designed considering both conveyors operating simultaneously.

Allowable vertical deflection of gallery girder shall be restricted to span/400. Vertical deflection of beam supporting conveyor short supports is to be restricted to span/450. Horizontal deflection of end portal is to be restricted to height/325. For trestles and junction towers, it shall be restricted to height / 1000 across the conveyor direction and height / 500 along the conveyor direction.

Conveyor Gallery connecting JT and bunker bay shall be resting on the bunker bay structure at bunker end. Necessary loading details of conveyor gallery shall be considered to design the bunker bay columns supporting the beam and gallery. Necessary Supporting Beam for conveyor gallery and Brackets required at the bunker bay end shall also be provided.

While casting the bunker floor, necessary insert plates for fixing the rail shall be provided.

Foundation design for Junction Towers and Trestles in the Power House region shall take care of the foundations of nearby main plant facilities within the available space.

4.22.04

Crusher House

Crusher house shall be of steel structure of framed / braced design. Intermediate Floors and roofs shall be RCC over metal deck sheet on structural steel beam. Side cladding shall be Fly ash brickwork up to 3.0m height from FFL Above that metal cladding as per architectural specification. Roof shall be given adequate slope for drainage. Roof shall be given with proper water proofing, as per description mentioned elsewhere in this specification. Proper arrangement shall be provided to convey the rain water through gutter of matching colour and DI down comers as specified elsewhere. Roof shall be provided with RCC Parapet.

Adequate number of aluminium glazed windows shall be provided as specified elsewhere. Wherever monorails are projecting outside (projection shall be as per technological requirement) for lifting of equipment, hollow metal sliding flush doors shall be provided. Main entrance doors shall have electrically operated rolling shutter adequately sized to carry equipment inside. Other doors shall be of hollow metal flush doors. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall

be of RCC. Intermediate floor shall be RCC over metal deck supported on steel beams. Handrail shall be provided around all openings with RCC kerb.

Minimum clearance of 1.5m shall always be provided around any equipment / structure / pedestal inside the building.

Two staircases shall be provided upto the roof one inside and one outside, both of structural steel. Elevator shall be provided. Machine room of elevator floor and roof shall be of RCC over metal deck sheet. Elevator pit shall be provided as per the system requirement. Side cladding of M/C room shall be of colour coated sandwiched cladding system. An RCC kerb wall of 300 mm shall be given around the floor and 100mm kerb around openings. M/C room shall be given adequate slope for drainage purposes with 150mm dia DI down comers. Roof shall be given with proper water proofing, as per description mentioned elsewhere in this specification. . Main door to M/C room shall be of hollow metal flush door. Adequate ventilation shall be given using aluminium glazed window. Toilet shall be provided in the Crusher house. Elevator pit shall be kept at least 500 mm above general grade level to prevent flooding. A sump shall be provided inside the pit to collect and pump out water. Sump shall be given with access ladder.

Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth beams. Top of the pedestals for the columns shall be above finished ground floor level as specified elsewhere.

Side cladding shall be with permanently colour coated profiled zincalume steel sheets double skin with insulation inside. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 3.0m height above finished ground floor level shall be of 230mm thick fly ash brick wall plastered on both faces. Grade slab shall be of RCC. Permanent metal decking shall be used for support of floor slabs. Within this building cubicles are to be provided for resting room of operators and these shall be constructed with one brick thick fly ash brickwork having both sides plastered and RCC roof slab. Vertical bracings shall be provided only on four sides along the periphery. No vertical bracings between columns shall be allowed inside the floor

Plinth protection, garland drains and approach road are to be provided.

Necessary provision of hoisting and handling arrangements shall be as per technological requirement.

Below the monorail projection, RCC paving in M30 (5 m wide upto road) shall be laid at the grade level for loading unloading.

The entire crusher house shall be designed as per approved mechanical drawing.

Crusher Foundation

The crusher shall be supported on M35 grade RCC deck slab mounted on vibration isolation system comprising springs and viscous dampers, which in turn shall be supported independently on ground-supported RCC frame structure. The crusher foundation and columns shall be made isolated from crusher building & this shall suit to process requirements. Crusher foundations shall be kept isolated by providing 75 to 100 mm gap all around at crusher floor level as per process requirements. The vibration isolation shall be done by providing inertia block with anti vibration pads. These pads shall be suitably procured with respect to crusher manufacturer's specifications.

(or)

The crusher shall be supported on M35 grade RCC deck slab mounted on vibration isolation system comprising springs and viscous dampers, which in turn shall be supported on suitably designed steel floor beams to avoid transmission of vibration. Steel beams shall have the limiting deflection as per VIS, OEM recommendation.

Detailed dynamic analysis shall be done for top deck of coal crusher together with springs & dampers and natural frequencies & amplitudes of vibration shall be determined. A mathematical model of top deck shall be formulated with three dimensional beams, plate, and finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffness. The mass of the machine together with that of the top deck shall be considered for the analysis. Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out for the unbalance forces generated during operating condition using a sinusoidal forcing function. Unbalanced forces as given by the manufacturer shall be used for this purpose.

Ultrasonic pulse velocity (UPV) test shall be carried out for crusher foundation to ascertain the homogeneity and integrity of concrete. Testing shall be done as per IS: 13311 (Part-1). The defects shall be rectified by using cement / epoxy grout etc.

Isolation Efficiency

The vibration isolation system shall be designed for about 90% isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction of achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly foundation isolation efficiency criteria and de-coupling required.

The bending mode frequency of the top deck shall be at least 20% above the operating speed.

Unbalance Forces

- i) Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.
- ii) Balance quality grade Q40 as per VDI 2060-1966.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions:

Operating speed of 750 RPM:

- i) 150 microns for an unbalance force arising out of balance quality grade Q40 as per VDI 2060.
- ii) 300 microns in case of a one hammer broken condition.
- iii) Amplitudes need not be checked for a three hammer broken condition.

Operating speed of 450 RPM:

- i) 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI-2060.
- ii) 300 microns in case of a one hammer broken condition.
- iii) Amplitudes need not be checked for three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM, the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

Transient Resonance

Transient resonance, which may occur during the start-up or coasting down

condition of the crusher, shall be checked and the amplitudes in such a condition shall not exceed one – and half times those at operating speed for each design condition.

Strength Criteria

The following criteria shall apply for the design of top deck:

- i) Dead loads, live loads, seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall be considered for design.
- ii) Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the crusher.
- iii) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.
- iv) Working stress method shall be used for the design of RCC deck. In survival condition, 10% overstressing may be permitted.
- v) The RCC top deck shall be at least of M35 grade of concrete as per IS:456.
- vi) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall not exceed the value specified by the manufacturer.
- vii) Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

Door, Window and other finishes shall comply with Architectural specification.

DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.22.05

Coal Handling System Maintenance Building

This building shall be single storey steel structure of framed / braced design (40m x 20m - Minimum). Minimum clear Height of Coal Handling Maintenance building shall be as per mechanical functional requirement and crane movement requirement. Roof shall be RCC over metal deck on structural steel beam. Crane Supporting Structures shall be provided including Supply and Erection of EOT Crane of capacity as per the Technological Requirement. Side Cladding shall be of Fly ash brick.

RCC ground floor slab shall be provided as per architectural/technical rule.

Steel door and aluminum glazed windows with steel grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

Toilets are to be provided in the building as per the technical rule. 150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Stair case shall be provided upto Roof and with parapet.

4.22.06

Control Room-Cum-Switchgear Room

This building shall be two storeyed RCC framed structure. Floor and Roof shall be RCC and Side Cladding shall be of Fly Ash Bricks.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

False ceiling, AC & ventilation ducts, cable galleries, inserts, concealed /conduit wiring as per technological requirements are to be provided. RCC stair case shall be provided from GF to Roof. Roof shall be provided with RCC Parapet of 125mm thick and 1000mm height.

HT Transformers shall be placed outside the building with fencing, gate, soling & paving, drainage system are to be provided. LT Transformers shall be accommodated within switchgear room.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.22.07

DFDS/Misc. Pump and Compressor House

This building shall be single storey RCC framed building. Roof shall be of RCC. Side Cladding shall be of Fly Ash Brick. Pumps, Compressor and other associated equipment shall be placed on Ground Floor. Monorail of suitable capacity shall be provided for necessary equipment Handling. All civil works including one RCC storage tank required for DFDS/DE/Ventilation system are under this scope.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

RCC Stair case shall be provided upto Roof and with parapet.

Drive House

This building shall be Steel framed building. Roof shall be of RCC over metal deck. Side Cladding shall be of single skin metal sheet. Monorail of suitable capacity shall be provided for necessary equipment Handling. All process and mechanical requirement shall be fulfilled.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided.

HGTU/VGTU

VGTU or HGTU shall be provided as per the mechanical requirements. Provision for monorail with hoists shall be provided as per mechanical requirements. In take up tower chequered plate platform shall be provided at every 3m height. All openings shall be provided with hand rails. Provision of Structural steel staircase shall be kept from GL to topmost platform.

4.22.08

Different Equipment Foundations for Coal Handling System

Foundations shall be designed, detailed and provided for the equipment for Coal handling system and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

- a) Foundations required for the equipments as listed in mechanical specification inside crusher House , Junction Tower, Coal Bunker Unit-1 , Unit-2 & Unit-3
- b) DFDS Pump & Compressor, Air receiver foundations, PVC water tank foundations on top of all buildings, Crusher House & Junction Towers, Different electrical equipment foundation like Transformer, Electrical Panel etc

4.22.09

Receiving Tower

This building shall be Steel framed building. Roof shall be of RCC over metal deck. Side Cladding shall be of single skin metal sheet. Monorail of suitable capacity shall be provided for necessary equipment Handling. All process and mechanical requirement shall be fulfilled. All other facilities shall be similar to Junction towers.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers are to be provided. Plinth protection, garland drains and approach road are to be provided.

Stair access upto roof shall be provided.

4.22.10 Dozer Shed

Dozer shed area shall be minimum 500 sq. m which includes space for Dozer, maintenance space, store, toilet. Electrical hoist capacity as per mechanical volume with monorail shall be provided for handling purpose. Other facilities like service water, service air, and necessary electrical shall also be provided by the contractor.

4.23.00 Ash Handling System

Major Structures in AHS are discussed below. For detailed specifications of Ash Handling System, Volume II-H1 of this specification shall be referred to. Ash handling areas shall have suitable surface drainage facilities

4.23.01 Compressor House Including Switchgear Room and Main Control Room

Compressor House equipment room shall be single storied and Switchgear Room and Main Control Room Shall be Two storeyed RCC framed structure with RCC Floors and RCC roof and fly ash brick wall cladding. Both Compressor house equipment room and switchgear shall be located side by side. Crane Girder /monorail shall be provided for handling of Compressor and other associated equipment as per mechanical requirement. Necessary corbels with embedment plates shall be provided in the RCC columns for erecting crane girder, if required. Stair access to roof shall be provided.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed/conduit wiring as per technological requirements are to be provided.

For Transformers outside control room, fencing, gate, soling & paving, drainage system are to be provided.

Door, Window and other finishes shall comply with Architectural specification. Main entrance shall be provided with electrically operated Rolling Shutter with RCC Ramp.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.23.02 Ash water Pump House including sump, Sealing Water Pump House including sump and Switchgear & RIO Room

Ash water Pump House and Sealing water Pump House shall be single storeyed Steel framed structure with RCC Floors and RCC roof supported on Metal deck Sheeting. Side Cladding shall be of Fly ash Bricks. Sump shall be of RCC Construction. Ash water pumps, Sealing Water Pumps and their associated equipment shall be supported on Ground Floor. Provision shall be kept for crane/monorails for handling of equipment. Stair access to roof shall be provided. Ash water tank & sealing water tank shall be of RCC located above the ground level. The tanks shall be designed as a water retaining structure as per IS: 3370. RCC sumps for Ash Slurry Pump house shall be designed as per IS: 3370 duly considering water table as well as additional surcharge pressure. RCC staircase shall be provided for access to bottom of all the sumps. All basements shall be provided with handrails all-round.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

The tanks and sumps shall be designed as Tightness class 3 in accordance with IS: 3370 (Latest Revision).

4.23.03 **Silo Utility Building cum HCSD Pump House including Switchgear RIO Room**

Silo Utility Building Including Switchgear Room shall be Single storeyed RCC framed structure with RCC Floors and RCC roof. Control room shall be of RCC construction with RCC roof. Side Cladding shall be of Fly ash Bricks. Provision shall be kept for crane and monorail for handling of equipment as per Mechanical specification.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed/conduit wiring as per technological requirements are to be provided.

For Transformers outside control room, fencing, gate, soling & paving, drainage system are to be provided.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

Stair access upto roof shall be provided

4.23.04 RCC Fly Ash Silo

- i) Fly ash silo shall be of circular cross section and shall be of RCC construction. The capacity of the silo shall be as per process requirement.
- ii) The silo shall be designed as per the requirement of IS: 4995. The minimum thickness of the silo wall, hopper, roof slab shall be 200 mm.

The following additional checks shall be done while designing the silo wall :

- a) Actual Stresses in Concrete and steel shall be checked with the permissible stresses as per relevant IS codes.
- b) Crack width (0.2mm allowable) shall also be checked for combined tension with bending as per the relevant design standards.
- iii) The silo shall be designed for the following conditions:
 - a) The silo is full with ash upto its full height / capacity
 - b) The silo is partially empty with top surface of ash, at an angle of repose less than 30 degrees.

The following loads are to be considered for design:

- i) Density of fly ash to be considered for volume calculation shall be 750 kg/cum.
- ii) Density of fly ash to be considered for load calculation shall be 1600 kg/cum.
- iii) Density of dry fly ash to be considered for the design of supporting structures for dry fly ash conveying pipes, shall be taken as 1000 kg/cum. The pipe shall be considered full with dry fly ash
- iv) The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3rd portion. **Special attention shall be given in assessing the effect of hot temperature of ash on the concrete wall. Temperature of ash shall be taken as 130 Deg C.**
- v) Roof over silo shall be RCC slab supported on structural steel beams. Operating floor and silo bottom floor shall be RCC slab supported on RCC beams. One Airtight RCC manhole shall be provided in the roof of each Silo.
- vi) External surface of Silo shall be painted with Sandtex matt, two coats

over one coat of primer.

Other requirements are as follows:

- i) Structural steel staircase with intermediate platforms and inter-connecting the silos at operating and at roof levels shall be provided. Monorails shall be provided as per process requirement. Suitable formwork shall be provided to achieve smooth surface finish inside the silo.
- ii) Independent supporting structure shall be provided for each silo.
- iii) The minimum clearance between Silo operating floor Beam / any item and the top of the ground floor paving of the silo area shall be 7.0m minimum.
- iv) There are Six (6) nos. of Silos, two (2) nos. (Interconnected) for each unit. Total three (3) nos. structural Staircase with GI gratings shall be provided one at each end. Inside the silo at the hopper portion, there shall not be any flat surfaces.
- v) Top level platform and operating platform for all silos shall be interconnected. All platforms shall be of GI gratings.
- vi) The silo supporting structure shall also support all the equipment, instruments, fittings and attachments associated with silos, such as aeration system, dust separators, hoists, ventilation filter, all valves including the valves below silos, rotary feeders with measuring arrangement, hydromix conditioners along with associated water piping and valves, dry fly ash unloaders. Necessary inserts / embedment may be provided wherever required.
- vii) The silos shall be supported at top and at bottom of cylindrical portion. The silo outlets provided at the bottom of silos shall have adequate lateral restraint to prevent vibrations.
- viii) The framing arrangement shall be provided in such a way that the trucks and closed tankers can have a clear passage with min 7.0m high to approach the underside of the silos for unloading dry ash from the silos.
- ix) Independent access for trucks shall be provided below each silo. The trucks / tankers shall be able to leave in forward direction without reversing. There shall be two passageways for truck / tanker movement under each Silo. The Silo orientation shall be such that, at a time two ash tankers shall be parked, below each Silo.
- x) The columns of supporting structure shall have ties in longitudinal as well as transverse directions.

- xi) The entire area below Silos and enclosed by road shall be RCC paved with RCC Garland drains connected to the plant main drains.

All drains in AHS area shall be provided with RCC Drain Sumps with minimum 5m³ capacity and the overflow water only shall be led to the plant main drains.

4.23.05

All Civil Structural Works related to pipe racks for Ash pipe lines, Air Pipe Lines, Water Pipe Lines, Misc. drain sump, Cable Rack, Cable Trenches and supporting structures

Pipe support works shall include, ash slurry pipe supports from ash slurry pump house to ash dyke including garlanding and to mine void is in the scope of contractor. Pedestals including insert plates for supporting pipes on bridge across Bhedan river and approach ramp are in the scope of Owner. However any clamps for fixing the pipes is in the scope of contractor. The necessary input for design of pedestal in bridge and approach ramp shall be provided by the contractor to owner. RCC thrust block for ash slurry pipe lines at the start and end of bridge approach ramp as per design requirement shall be provided by contractor, only vertical load of ash pipes shall be transmitted in Bridge and approach ramp (Bridge and approach ramp are in Owners scope), dry fly ash pipe supports and RCC thrust block including any other supports required to complete the system requirement (Refer Clause 4.36.00 for Terminal points). The Pipe Lines and Cable Racks shall be supported on steel structures as per Mechanical requirement. The steel Trestles supporting ash pipes shall be so proportioned that the transverse deflection of trestles due to wind / seismic load shall not exceed trestle height/325 (For detailed specification of Trestles and gantries CHP section may be referred.). The Steel structures shall be supported on RCC Pedestals. The height of the RCC pedestals shall be minimum 600 mm from FGL. The foundations for pedestals shall be placed at minimum depth of 1.0m below natural ground level or on weathered / hard rock / Piles. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movements.

4.23.06

Seal Water Sump

Seal water Sump shall be located in the Ash water pump house to cater seal water requirement for Ash Handling System. Sump shall be RCC and designed as Tightness class 3 in accordance with IS: 3370 (Latest Revision).

4.23.07

Intermediate Surge Hopper for Fly Ash

Intermediate Surge hopper is a transit buffer arrangement to transfer ash from Vacuum Conveying to Pressure Conveying. The Intermediate Surge Hopper and its supporting structure shall be of structural steel. RCC foundation shall be provided to support the entire structure considering all possible loads.

4.23.08

Different Equipment Foundations for Ash Handling System

Foundations shall be designed, detailed and provided for the equipment for

Ash handling system and auxiliaries as described in Mechanical specification. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

4.23.09 **Pedestals for High Concentration Slurry Disposal from Silo**

Foundation with Pedestals shall be provided for the high concentration slurry disposal pipes (Refer Clause 4.36.00 for Terminal points). However, the number of pedestals shall depend on Length of disposal and Garlanding around Dyke. The pedestal heights shall be minimum 600 mm above FGL. However the height may be increased to maintain the gradient of the Pipes conveying slurry to the Dyke.

4.23.10 **INTENTIONALLY DELETED**

4.24.00 **INTENTIONALLY DELETED**

4.24.01 **INTENTIONALLY DELETED**

4.24.02 **INTENTIONALLY DELETED**

4.24.03 **INTENTIONALLY DELETED**

4.24.04 **INTENTIONALLY DELETED**

4.25.00 **Raw Water Makeup System**

4.25.01 **Raw water transfer Pump House & Switchgear Room**

Raw water Pump House shall be single storeyed RCC framed structure with RCC Roof and side cladding shall be of Fly ash Bricks. All necessary provisions to be made to support pumps, gates, screens and other misc. equipment. The operating floor shall be framed RCC Floor supported on RCC Sump Walls. RCC raft with Sump shall be provided with individual suction pit for each pump. The highest water level in a sump shall be such as to ensure a minimum clearance of 500 mm below the lowest concreted portion of the floor in the pump house. The superstructure shall have gantry girder for EOT crane of capacity as specified in technical specification. Electrically operated MS rolling Shutter to be provided towards approach road side. Doors, windows and toilets shall be as per architectural specifications. Necessary storage water tank shall be provided on roof. Approach to roof through staircase shall be provided. Substructure shall be designed as un-cracked section.

Separate Electrical Room with all necessary electrical systems like panels, switchgear and air conditioned control room shall be provided. Roof extractors shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the buildings

as per the technical rule.

The tanks and sumps shall be designed as Tightness class 3 in accordance with IS: 3370 (Latest Revision).

If there is an intake fore-bay at the entry of the pump house, the angle of inclination of the side walls of the fore bay with the direction of water flow shall not exceed ten (10) degrees under any circumstances. PRV is not permitted.

4.25.02

Raw Water Reservoir

Reservoir shall be constructed to build up raw water storage capacity as indicated in Mechanical volume.

The reservoir shall be formed with top of the bund shall not exceed 204.0m including free board of 1.5 m and bottom level shall be kept to meet the storage capacity. The bed / bottom level of the RWR shall be at the discretion of the contractor fulfilling the above conditions of top level, storage capacity & freeboard. The top of bund shall be at same level throughout the length of the Raw water reservoir. Minimum height of top of bund shall be 1.5m above peripheral road level. The slope between vertical and horizontal of the reservoir shall be 1:2.5. The outer slope of the embankment shall be protected from rain cuts by turving with sods / clods. Any excavated material not required or not suitable for embankment construction shall be disposed-off in the place shown to fill the low lying areas inside/outside the plant area spreaded in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils with a lead 5-6km.

Inside and bottom surface shall be lined with impermeable LDPE lining of thickness minimum 1000 micron with overlap distance of 0.5M and jointing of LDPE lining with robotic 2 stitch welding, to prevent loss of water due to seepage. The liner shall be placed over minimum 50 mm thick fine sand. Arrangement for holding the liner in position by providing necessary RCC beam at top level of embankment shall be kept. The liner shall be protected by precast concrete tiles placed over it. Dimensions of precast concrete tiles M30 Grade laid over LDPE sheet shall be 300 x 300 x 50 mm – laid over 25 mm thick 1:4 cement mortar. The jointing and pointing between tiles shall be done with 1:3 cement mortar.

The top of embankment (of reservoir) shall be minimum 1.5m (free board) above the maximum water level of the reservoir. The area all around the reservoir shall be graded to RL 201.00 M for construction of peripheral / inspection road. The construction of embankment shall be done by excavating soil from the reservoir area and after establishing that the soil is fit for embankment formation by conducting suitable soil tests and after getting approval from the Engineer-in-charge for the soil test. If the excavated earth is not suitable for bund formation, it shall be disposed of and suitable earth shall be brought from nearby borrow pits with in a lead of 20 km shown by the Owner without any extra cost. During detail engineering the contractor shall develop reservoir by excavation/filling as per the topographical details/contour

drawing such that the required capacity of reservoir can be achieved by way of optimized cutting and filling.

The stability of internal and external slope of the dyke shall be designed to ensure with a FOS of minimum 1.25 due to surcharge load of 1.0 t/m^2 at the top of dyke. Top width of the bund for Reservoir shall be 5 M including road. Top of the bund shall be provided with minimum 4m wide WBM (two layers of 75mm compacted thick over 230mm consolidated thick stone boulder / laterite soling as per specification) road with slope at one side from inner to outer edge.

4.0m wide BT inspection road shall be provided as per plot plan.

PCC (M15) chute 900 mm width with plaster finish at 30 M intervals shall be provided all around the periphery of the embankment of the reservoir to drain out the storm water from embankment top. All the chutes shall be connected to the outer peripheral RCC toe drain. PCC (M15) kerb stones of size 600mm x 450mm x 100mm thick shall be provided on both sides with 300mm projection above road level of the bund top and shall be flushed with chutes.

At the inner face all-round GI chain link fencing of 2.4 m height shall be provided.

Suitable PCC (M-15) steps (min. 1.0m width) with plaster finish shall be provided at the inside as well as outer edge of dyke along the periphery to access at the top at all turning points and at longer stretches, such steps shall be provided every 300M. Approach ramp wherever required (at least in 2 locations) shall be provided. The Ramp shall be of RCC over the embankment with M30 grade concrete minimum 200mm thick with 2 layers of 10mm reinforcements running both ways shall be provided. External protection works shall be with grass turfing. Rock toe shall be provided as per IS and design requirement.

RCC box culvert for overflow arrangement along with weir on the top of the bund shall be provided. RCC apron all along the overflow arrangement along the outer face of the embankment is to be provided. The apron shall be in RCC stepped slab having foundations at regular spacing based on the design requirement and founded inside the bund. Apron shall have RCC kerb in the form of wall along the apron edge on both sides having the height equal to the top level of culvert. The grade of concrete shall be M30. The over flow arrangement shall be designed suitably. RCC apron shall be connected to the RCC over flow drain at the bottom of embankment. RCC over flow drain shall be provided from RWR, crossing the peripheral road outside the compound wall and terminated at 20m from outside edge of peripheral road to discharge over flow water of the RWR to outside the Plant boundary. RCC box Culvert shall be provided for all Road crossing. MS grill with 16mm steel Rod mesh shall be provided at Compound wall crossing if any.

The founding level of the embankment / bund formation shall be at least 600 mm below the NGL. The layers of bund formation shall not exceed 150 mm per layer.

Toe drain made of RCC of minimum 300 mm depth & 450 mm wide all-round the Reservoir is to be provided and shall be connected to the nearby over flow drains.

The foundation shall be prepared by removal of weak and organic materials, compaction by rolling, filling the voids and controlling the moisture on land surface. The dykes shall be designed and constructed in layers compacted with rollers appropriate to the soil used to achieve dry density of at least 95% of standard Proctor density at OMC.

Provision of cut-off trench filled with impervious soils below dyke section shall be made to increase the length of seepage water flow in the foundation, thereby controlling the exit gradient, which safeguards the erosion.

As per IS, Filter media with alternative layers of sand and pebbles shall be provided in the bund as per the design requirement at desired locations in the bund. The filter media shall be 1500 mm below the top of the bund and led to the rock toe. Sand Chimney, Rock toe and any other codal requirements for the Successful formation of embankment shall be in Contractor's scope.

Necessary slope stability of the embankment with capacity calculations along with design document shall be submitted in line with the IS requirements.

4.25.03 Equipment Foundations

Different Equipment Foundations for Raw water Makeup System

Foundations shall be designed, detailed and provided for the equipment for Raw Water Makeup system and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required by mechanical specification for completeness of the system are also in the Contractor's scope.

All Civil & Structural Works for Raw Water Pump House and Raw water Transfer Pumps are in the scope of the Contractor.

4.26.00 Water Treatment System

4.26.01 Chemical House/Lab

Chemical house shall be a two storied concrete RCC framed building housing various chemical solution tanks, chemicals, pumps, MCC and control room. Provisions shall be made for Chemical storage room, coal sample preparation room, coal and Oil analysis room and AC rooms such as Office room, Environmental testing room, Water analysis room, Special testing room, etc.

Air conditioned area shall be provided with split air conditioners with false ceiling. All other area shall be provided with mechanical exhaust with 20 air changes per hour and ceiling fans.

The covered finish floor area space for all the laboratories including laboratory, chemical & glassware storage room and office area shall not be less than 600 sq. meters. The laboratory is two story building with each floor area of minimum 300 sqm. The laboratory premises shall be provided with concealed pipework for compressed air, de-mineralised water, potable / service water with valves and sufficient nos. of the power points for laboratory equipments all along the lab at specific locations. RCC Platforms of minimum 1 m width and at a level of 0.9m from FFL shall be provided with Porcelain sink as per the mechanical requirement. The platforms shall be finished with Glazed ceramic tiles with dadoing above upto lintel level.

Adjoining the chemical house there shall be chlorine ton container storage room and chlorinator room. The chemical house shall have sufficient unloading space, wide corridors, office space, etc. Clear height of 5.5m (minimum) shall be provided in each floor. The building shall be complete with RCC roof, Fly ash Brick wall as side cladding, plastering, doors, windows, rolling shutters, flooring, plaster, painting, roofing, etc. and all other items necessary for satisfactory performance of the building. The building shall have toilets and the scope shall include supply and fixing W.C.'s urinals, showers, eyewash facilities and all plumbing sanitary and other work required for satisfactory completion of the above building. The tanks and parts of floor slabs shall be lined with Acid/Alkali proof tile lining. Monorails of adequate capacities shall be provided as per functional requirements.

Walkways, platforms with hand rails shall be provided to have clear access from Chemical House to different units like Stilling Chambers, Parshall flumes, Distribution Chambers, Clarifiers etc. and also various sub-systems/units of Water Pretreatment Plant. Walkways shall be provided with concrete interlocking blocks as per architectural specification.

Door, Window and other finishes shall comply with Architectural specification.

RCC Clarified water tank of capacity mentioned in the mechanical volume shall be provided.

DI Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in each floor of the building as per the architectural / technical rule. RCC stairs up to the roof shall be provided. Parapet as per architectural requirement shall be provided.

4.26.02

PW Chlorination Plant Building

The Chlorination Plant Building shall be a single storied RCC framed building with RCC roof housing the chlorination plant. Hoists with monorail shall be provided for normal plant operation and for handling of equipment during erection/maintenance. The side cladding shall be with Fly ash Brick Work. The building shall be complete with plastering, doors, windows, rolling shutters, flooring, and painting, roofing, etc. and all other items necessary for safety and satisfactory performance. Access to roof through RCC Stair shall be provided. Parapet as per architectural requirement shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

DI Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the architectural / technical rule

4.26.03 **UF Permeate Storage Tank and Pump house, Degassed water storage tank & pump house**

Tank and pump house shall be single storied steel framed structure. Roof shall be of sloped structural steel construction with single skin zincalume sheet and sides shall be open. There shall be hoist and monorail of required capacity for handling of pumps. The Storage tank shall be as per system requirement and of RCC construction.

Door, Window and other finishes shall comply with Architectural specification.

DI Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.26.04 **DM Plant Building with switchgear room, control room, MCC Room**

DM Plant Building with switchgear room, control room shall be of single storied RCC framed structure with RCC Floor and flat RCC roof. Side cladding shall be of Fly ash Bricks. MCC room, Control room and maintenance bay shall be part of DM plant building. Underslung Crane to be provided in DM plant building for handling equipment.

Separate Central Chemical Laboratory shall be provided as per specification. Equipment foundations & trenches in ground floor slab shall be of reinforced concrete. Ground floor shall be provided with ironite flooring except at locations, which may come in contact with acid/alkali where acid/alkali resistant tile lining with epoxy mortar shall be provided. Effluent drain trenches shall also have acid proof lining at inside surfaces of drain as well as soffit of pre-cast removable covers.

Door, Window and other finishes shall comply with Architectural specification. Access to roof through RCC Stair shall be provided. Parapet as per architectural requirement shall be provided.

DI Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.26.05 **Foundation for DM Water Storage Tanks**

The DM storage tanks shall rest on a flexible foundation and shall consists of hydraulically compacted clear river sand, in layer of 200 mm thickness to achieve a relative density of 75%, using suitable compaction equipment, topped with 150 mm thick PCC. The PCC layer shall be topped with 50 mm

thick anti-corrosive asphalt layer, which in-turn shall be topped with a 50 mm thk layer of premix carpet. The entire sand fill along with toppings shall be confined within a RCC ring wall of appropriate design. The foundation system shall be designed as per IS: 803.

Minimum 2.5 m wide RCC pavements shall be provided around each outdoor equipment. Drain arrangement shall be made as per the requirement.

4.26.06 **Acid/Alkali storage tank**

Acid / Alkali storage tanks shall be resting on RCC saddles on elevated RCC platform. The platform shall be supported on RCC beams, columns with RCC foundations. The saddles along with platforms shall be lined with acid/alkali proof tiles.

Acid/alkali storage and handling area shall also be lined with acid / alkali resistant 3mm thick PPG lining. Thickness of tiles shall be as per specification.

4.26.07 **Clarified Water Reservoirs and Pump Houses with SWGR/MCC Room for PT Plant and DM plant**

The Pump House shall be RCC Frame structure with RCC roof. Side Cladding shall be Fly ash Brick wall except for the portion of the building wall/cladding adjacent to Transformer. Clarified water tank shall be of water tight RCC construction having two compartments covered with RCC roof. It may be fully underground or partly underground with partly over-ground. Vent pipes shall be provided at roof. Clarified water tank including RCC roof shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**.

The clarified water pump house shall be complete with plastering, doors, windows, rolling shutters, flooring, painting and all other items necessary for satisfactory performance of the building. Cast-in-situ RCC crane girder or steel girders shall be provided as per specification. MCC room shall also have to be provided. Suitable windows, doors, access to roof through RCC Stair and parapet shall be provided in accordance with Architectural specification.

Minimum grade of concrete for clarified water tank shall be M30. All water tight structures shall have provision of contraction, expansion and construction joints. The structures shall have smooth finish and shall be given cement wash for decent appearance. The structure shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**. Door, Window and other finishes shall comply with Architectural specification.

DI Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the architectural / technical rule.

The pump house building shall accommodate necessary pumps as specified in concerned Mechanical volume and associated transformer (with RCC fire wall), switch gear room, control room and all electrical equipment. The portion of the building wall/cladding adjacent to Transformer shall be of RCC wall.

Fire Pumps and other associated equipment shall be placed on Ground Floor of Clarified water. Monorail/Crane shall be provided for necessary equipment Handling.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed /conduit wiring as per technological requirements are to be provided.

Fire water tank to be provided as per concerned Mechanical volume..

4.26.08 **Sludge Sump and Neutralization-pit as per system requirement**

The sludge sump shall be an underground RCC sump; part of the sump shall be covered with RCC slab for supporting the sludge pumps. MS steel shed with zinc galvalume sheeting shall be provided for the Sludge disposal pumps. Gravity flow of sludge to Sludge sump from tube settler, clarifiers, stilling chambers, Distribution Chambers, etc. shall be ensured.

Neutralizing pit shall be designed as a water retaining structure with external damp proofing. Floor and internal surface of walls of the pit shall be given PPG (Plastic Polypropylene Glass) lining as per Technological specification.

4.26.09 **Tanks and Equipment Foundations**

Different Tanks and Equipment Foundations for Water Treatment System

Foundations shall be designed, detailed and provided for the tanks and equipment for Water treatment system and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

Clarified Water Pump House - FGD Makeup pumps, APH wash Pumps, CT Makeup Pumps, Service water Pumps. Foundation for Pressure Sand Filter shall also be provided

Concrete channel shall be provided with proper design and detailing as per design criteria. Shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision).**

4.26.10 All Civil and Structural works related to Stilling chamber, Flash Mixer,

Clarifiers, inlet channels, Sludge Thickener, RCC Sludge Sump, Centrifuge etc. along with associated facilities for Pre-Treatment Plant shall be done as per functional requirement and as per technical criteria. Also foundation for Various Dosing Tanks, Pumps and Motors etc. as per System requirement shall be under contractor's scope.

Stilling chamber, (2nos)

Stilling chamber shall be of RCC construction with a minimum capacity as mentioned in mechanical volume. Suitable draining arrangement shall be provided from stilling chamber to nearest sludge well/sludge pit for final disposal to Sludge Sump.

Flash Mixer (4nos)

Flash Mixers are RCC construction with minimum retention time as mentioned in mechanical volume.

Clarifier (HRSCC type) (4nos)

It shall be partly above ground and partly below ground upto a maximum underground depth of 1.5m. However foundation shall be placed 1.00m below NGL. It shall be designed with required overloading margin as mentioned in mechanical volume. The retention time shall be as per mechanical volume. The clarifier unit shall be circular, central feed type with concentric recirculation zone (rapid mixing), reaction zone (slow mixing) and clarification zone in RCC construction. The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom. Suitable scum collecting arrangement shall be provided in the clarifying section for removal of floating debris, foam, etc. Clarifier shall be provided with a gate at the outlet for isolation of any of the clarifier for maintenance. Draining arrangement shall be made from clarifier to Sludge Sump for the disposal of sludge.

Inlet channels

Four RCC inlet channel shall be constructed for connecting stilling chamber to four flash mixers. Necessary fixing arrangements shall be made in the channels for Parshall Flume, flow indicators, etc. as per the mechanical requirement.

Sludge Thickener

Two numbers of Lime slaking tanks, two numbers of Lime solution Preparation tanks and two numbers of FeCl_3 solution preparation tanks in RCC shall be constructed with PPG lining inside as per the mechanical requirement.

Foundations shall be designed, detailed and provided for the major equipment for DM Plant and auxiliaries as described below. This list is indicative only. Any other equipment / components as required for completeness of the system; foundations of the same are also in the Contractor's scope.

- Foundation for Various Dosing Tanks, Pumps, Motors etc. as per System requirement
- Foundation for various Transfer Pumps, Motors etc. for DM System (i.e. Degassed Water Transfer Pumps, MB Feed Pumps, Ultrafiltration Feed Pumps, DM Water Transfer Pumps etc.) as per process requirement.
- Foundation for various Backwash Pumps, Blowers, Motors etc. for DM System (i.e. PSF Backwash Pumps, Air Blowers for PSF, UF Backwash, Blower for MB Exchanger etc.) as per process requirement.
- Equipment Foundations for Pressure Sand Filters, Ultra Filtration Skids, Cation Exchanger, Anion Exchanger, Mixed Bed Exchanger, Degasser Tower, Degasser Blower etc.

Required Foundations for Chlorine Tonners, Chlorinators, Gas Filters, Injectors, Caustic Solution tanks, Blowers etc. shall be under Contractors scope under RW & PW Chlorination System.

All RCC water / liquid retaining and conveying structures shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**. Water proofing admixtures shall be added in the concrete. PVC water stoppers shall be provided in construction / contraction / expansion joints and the joints shall be properly sealed as per the architectural specifications. Plinth protection with garland drains shall be provided around all the structures / facilities.

4.27.00 Circulating Water System

4.27.01 CW Pump House with Switchgear Room

Circulating water pump house along with Electrical Annex building Switchgear room shall be single storied steel frame building. CWPB roof shall be RCC supported on Metal deck Sheet and RCC roof for annex building. Adequate Roof Extractors shall be provided. Side cladding shall be of Fly ash Brick wall for annex building and single sheet Zinacalume cladding over 1.0m high Fly ash brick wall from FFL for main Pump house. The electrical annex building (switch gear room) shall be 800mm above FGL.

Separate unloading and maintenance bay to be provided for CW pump house.

Separate bays shall be provided for each pump by providing intermediate dividing piers of RCC between the pumps. The building shall be provided with lifting & handling crane facility of the capacity as per mechanical specification.

CW pump house shall be designed for Concrete Volute type pumps.

For concrete volute type, the suction draft tube and pump volute casing shall be of cast-in-situ concrete construction. Inner lining/finishing shall be done as per mechanical specification.

Reinforcement shall be Fe500 CRS (IS1786) and concrete grade shall be M30. Ordinary Portland cement namely Grade 43 shall be used. Minimum wall thickness shall be 200mm. Cover to concrete is 50mm minimum on all faces...

Thrust blocks shall be provided in CW Pump house at the change of direction in the Suction pipe as per the design requirements.

All the CW pump sumps shall be provided with required number of MS stop log gates as indicated in specification for the respective pump bay along with electrically operated semi-gantry crane. Steel embedment required for stop logs shall be provided for all the bays. Overhead EOT crane with necessary hoists shall be provided inside the Pump House as per the mechanical requirement.

All bays of pump sump shall be provided with a removable coarse screen including electrically operated semi-gantry crane. Steel embedment required for trash racks shall be provided for all the bays. MS Ladder/rungs shall be provided in each sump and finished as indicated in mechanical volume.

The sub-structure of pump houses including their fore-bays shall be RCC with M30 grade of concrete conforming to IS: 456.

CW pump house shall be structurally separated from fore-bay by providing an expansion joint. The pump house shall be provided with separate unloading and maintenance bay.

The RCC Sump of the pump houses shall be designed as Tightness class 3 in accordance with IS: 3370 (Latest Revision).

The pump house sub-structure & fore-bay shall be analyzed and designed for overturning, sliding & uplift.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Suitable access to the roof through RCC stair shall be provided.

Thrust block shall be provided for CW piping as per layout and design requirements. For road crossings of CW pipelines, RCC box culverts/RCC encasing shall be provided.

Cooling Water Channels

RCC cooling water channel shall be of rectangular shape and designed as a water retaining structure as un-cracked section. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel to the fore-bay to the pump house. Dimension of the channel shall be decided on the basis of the quantity of water to be carried by the channel and shall be in line with approved SUMP MODEL STUDY & CFD analysis. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above finished ground level with suitable galvanised MS pipe hand railing on either side. Expansion joint shall be given at a spacing of about 30 m. Pedestrian crossovers (at least in two locations) shall be provided across each channel as per good engineering practices. The channel shall smoothly diverge and form the fore-bay in front of the pump house. It is suggested that the bottom of the fore-bay shall be kept flat/slope and the difference in level between the channel and C. W pump sump shall be made up in the channel stretch before joining the fore-bay, using a slope as per Hydraulic Institute Standards (HIS).

Fore-bay

Invert level of fore-bay shall generally match with the C. W. sump level with proper slope, which shall be decided based on submergence requirement of the C.W. pumps at the lowest water level in the sump. Fore bay dimension shall be in line with approved SUMP MODEL STUDY & CFD analysis. Fore-bay shall be provided with cage ladder constructed of galvanised steel at four corners. Top of the fore-bay wall shall be kept at least 500 mm above grade level and handrail of galvanised M.S. pipes shall be given for the entire length. Water level indicator (float type) shall be provided in the fore-bay close to the pump sump on either side to observe the depth of water. Sandwich slab/Pressure relief valve may be considered for the design of fore-bay. It shall be designed as Tightness class 3 in accordance with IS: 3370 (Latest Revision). If sandwiched slab is provided for forebay, the minimum thickness of the top slab, bottom slab and divider shall be 300mm. Top and bottom slab shall be RCC and sandwich fill shall be of PCC M10 (Minimum). Factor of safety against uplift pressure shall be 1.2.

GI chain link fencing equal to the height of the hand railing shall be fixed over the Handrails for the entire length of the fore-bay and channels.

4.27.02

CW Treatment cum Chlorination Plant Building

CW Treatment cum Chlorination Plant Building shall be single storeyed RCC Framed structure with RCC roof. Side cladding shall be of Fly ash Brick wall. Chlorination plant building shall house chlorine toner and or chlorine / chemical dosing pump and auxiliaries. Necessary provisions for ventilation and erecting monorails, hoists etc. shall be considered.

Door, Window and other finishes shall comply with Architectural specification. At the main entrance electrically operated Rolling shutter shall be provided with RCC ramp. Additional doors shall be provided as per the functional

requirement. Access to roof shall be provided through RCC Staircase.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.27.03 **Equipment foundations**

Different Equipment Foundations for Circulating Water System

Foundations shall be designed, detailed and provided for the equipment for Circulating Water system and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

CW Pump House - CW pumps, Seal Water pumps (In case of concrete volute type CW pumps)

Required Foundations for Chlorine Tonners, Chlorinators, Gas Filters, Injectors, Caustic Solution tanks, Blowers etc. shall be under Contractor's scope for CW Chlorination System.

Required Foundation for Unloading / Storage Tanks, Dosing Tanks, Pumps, Motors etc. shall be under Contractor's scope for CW Treatment System.

Fore-bay, Concrete Channel shall be provided with proper design and detailing as per design criteria.

4.27.04 All related Civil and Structural Works related to Sump, Fore-bay, Channels from Cooling Tower shall be done as per functional requirement and as per technical criteria. Physical sump model study & CFD analysis for CW pump house along with fore bay and CFD analysis for CW Channel from CW pump house to cooling tower shall be done by the Contractor as per the requirement of Mechanical specification.

Each individual sump in the CW Pump house shall be designed in accordance with the recommendations specified in Hydraulic Institute / British Hydraulic Research Association/equivalent international standard and its dimensions shall be finally selected after conducting necessary sump model tests and CFD analysis.

The highest level of water in the CW pump house shall be such as to ensure minimum 300 mm clearance between below the soffit of the lowest floor of the pump house and maximum water level.

4.28.00 **Sewage treatment system**

Sewage treatment system shall be planned with two number of STP buildings with all the required facilities as per functional requirement. However, based on design requirements, a maximum of two number of additional modular STP

shall be permitted. These modular STP shall be located nearer to the plant boundary (within compound wall) with covered shed.

4.28.01 **STP Building 2 Nos**

STP Building shall be single storied RCC framed building with RCC Roof. Side cladding shall be of Fly ash Bricks. Roof shall be provided with roof treatment and RCC parapet. Access to roof through RCC Staircase shall be provided.

STP Building shall Include Control Room, MCC and Switchgear Room.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed /conduit wiring as per technological requirements are to be provided.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.28.02 **All Civil Works related to Sewage Conveying and Disposal system**

Sewer system shall be provided for the disposal of sewages from the toilets of different buildings / facilities. RCC pipe of class NP3 conforming to IS: 458 shall be used for the sewerage network which shall have manhole at an interval of maximum 30m, at changes in gradient, and at changes of direction or in straight stretches. At the road crossings the sewer line shall be encased with concrete of grade M20 (150mm thick) with skin reinforcement. The sewage shall be conveyed to Sewage Treatment Plant at suitable location through gravity. Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

The sewage network from the various toilet blocks of the entire area under EPC package and all Buildings like Thermal project site office. Building inside the Plant shall be properly planned. In addition, the sewage shall be inter-connected to the Main Plant Sewage network system which is in the scope of EPC package. The entire sewage generated from the entire power plant shall be finally let into the any one STP at two different locations.

The sanitary waste of all the toilets from different buildings of the plant shall be collected by gravity into the respective collection chambers and shall lead to common collection sump (Minimum 15m³ capacity each STP with 1m free board) under gravity flow only.

The Sewerage treatment plant shall be modular type based on FAB/MBBR technology followed by disinfection by Hypo and necessary tertiary treatment prior to reuse in horticultural purpose. The Plant shall be complete with all fittings and fixtures and shall include all ancillary works such as laying of sewage pipes, installation of Manhole and inspection chambers, Common Collection Sump, Bar screen & Oil & Grease chamber, equalizing Tank, Fab Tank, tube settler, Filter Feed Tank, pump house, treated water tanks, Sludge Pit etc. as per the system requirement.

The finally treated sewage shall meet the norms of environment protection rules 1986 and its amendments and the rules of CPCB / MOEF / State Pollution Control Board. The treated waste water from STP shall be used for gardening purposes in the power plant. Necessary pipeline, pumping etc. shall be in the scope of contractor.

All the sewer lines shall be designed such that the self-cleaning velocity is maintained to facilitate the maintenance of sewer lines. Sewer lines shall be designed considering peak factor as per guidelines of CPHEEO manual and shall run at 0.5 full at ultimate peak flow.

4.28.03 **Different Equipment Foundations for Sewage Treatment System**

Foundations shall be designed, detailed and provided for the major equipment for Sewage Treatment Plant and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

- Required foundation of TPI Separator along with its auxiliaries
- Required foundation for API along with its auxiliaries
- Foundation for Various Tanks, Pumps, Motors etc. as per System requirement
- Foundation for various Transfer Pumps, Motors etc. for STP System (i.e. Filter Feed Pump, Treated Water Disposal Pumps, Sludge Pumps etc.) as per process requirement.
- Equipment Foundations for Dual Media Filters, Activated Carbon Filters, Air Blowers etc.

4.29.00 **Effluent treatment Plant**

Waste water generated from the 3 x 800 MW plant shall be treated in a full scale effluent treatment system.

The oily / process waste water shall be transferred through pumping and waste water transportation system to Central Monitoring Basin for further treatment. The pipes shall be adequately sloped for drainage and shall carry flow to neutralization pit/Effluent Collection Sump /Oil water separator etc. as required. Plant effluent shall be discharged into the central monitoring basin,

which has been outlined in the Technical Specification of Effluent Treatment System Vol-II-IB/4.

After necessary dosing, waste water shall be transferred to Clear Water Sump through effluent collection reservoir and clarifier. This clear Water shall be treated by filtration, ultrafiltration and reverse osmosis and finally sent to clarified water reservoir. Necessary UF Water Storage Tank, Degassed Water Storage Tank etc. shall be under scope of contractor. All pumps under this system shall be accommodated inside the building or dedicated pump house / room as required.

4.29.01 **ETP Building Including pump house and control & Switchgear room**

ETP Building Including pump house, dosing system, Electrical Room (if required) and control room shall be single storeyed RCC framed building with RCC Roof. Side cladding shall be of Fly ash Bricks. Access to Roof through RCC Staircase shall be provided.

Pumps and other associated equipment shall be placed on operating Floor. Monorail/Crane shall be provided for necessary equipment Handling.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed /conduit wiring as per technological requirements are to be provided.

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.29.02 **ETP CTBD/RO building with effluent disposal system**

ETP CTBD/RO building shall be of single storied RCC framed structure with RCC Floor and flat RCC roof. Side cladding shall be of Fly ash Bricks.. Equipment foundations & trenches in ground floor slab shall be of reinforced concrete. Underslung Crane is to be provided in the building for handling equipment. This building shall have switchgear room, control room and Chemical / Consumable Storage Area. Approach to Roof through RCC Staircase shall be provided

.False ceiling, AC & ventilation ducts, cable trenches, inserts, concealed/conduit wiring as per architectural requirements are to be provided

Door, Window and other finishes shall comply with Architectural specification.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.29.03 Central Monitoring basin

Effluent Water from various sources shall be led to central monitoring basin for further treatment. The waste water from various sources shall be collected at CMB with the help of pumping system. These Pipes shall be laid on Pipe rack, Pipe sleeper or underground as per the layout requirement. Central Monitoring Basin shall have two compartment arrangements. The basin shall be of RCC Construction with sufficient capacity excluding free board (300mm minimum). Inlet and Outlet structures, accessories, overflow collection sump shall be of RCC Construction. Acid/alkali dosing tanks/pumps are provided for neutralizing the collected effluent. The Acid / alkali dosing and handling area shall be properly dyked and lined with acid / alkali proof bricks From the CMB the neutralized water shall be pumped to Effluent Collection Sump (CTBD Treatment plant). This CMB shall have common pre-settling compartment. CMB shall be underground type. The CMB shall be designed for minimum detention period as mentioned in mechanical volume.

Minimum grade of concrete for Central monitoring basin shall be M30. Water proofing admixtures shall be added in concrete. PVC water stoppers shall be used in joints. All water tight structures shall have provision of contraction, expansion and construction joints. The structures shall have smooth finish and shall be given cement wash for decent appearance. The structure shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision).**

4.29.04 Different Buildings/Equipment Foundations for Effluent Treatment System

Foundations shall be designed, detailed and provided for the major equipment for Effluent Treatment Plant and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

- Necessary Pump and Motor Foundations of Waste water Transfer Pumps at various effluent collections Pit.
- Required foundation of TPI Separator along with its auxiliaries
- Required foundation for API along with its auxiliaries
- Foundation for Various Tanks, Pumps, Motors etc. as per System requirement
- Foundation for various Transfer Pumps, Motors etc. for ETP/CTBD/RO System (i.e. CMB Overflow Pumps, Clarifier Feed Pump, DMF Feed Pumps, BA Overflow Seal Water Pumps, RO Feed Pumps, RO High Pressure Pumps, RO Permeate transfer pump, Parshall flume, Flash mixer, etc.) as per process requirement.

- Equipment Foundations for Dual Media Filters, Basket Filters, Ultra Filtration Skids, Micron Cartridge Filter RO Module, Degasser Tower, Degasser Blower etc.
- One (1) Backwash Water Storage Tank of RCC construction having effective capacity as mentioned in mechanical volume.
- One (1) RCC RO Reject Water sump of adequate capacity shall be constructed.
- One ETP reject treatment plant building to be provided as per G1-Sec-IV.

Clarifier

The clarifier unit shall be of RCC construction, circular, central feed type with concentric recirculation zone (rapid mixing), reaction zone (slow mixing) and clarification zone. It shall be designed with minimum retention time as per mechanical volume.

Chemical House

Feed Chamber of R.C.C. construction shall be provided. Feed Chamber shall provide a minimum residence time as per mechanical volume.

Clear Water Reservoir shall be of RCC construction with holding capacity as per mechanical volume.

Over-Head clarified water storage tank of RCC construction with minimum capacity as per mechanical volume.

ETP sludge sump of RCC construction with holding capacity as per mechanical volume.

Tilted Plate Interceptor Overflow Sump of RCC construction with minimum capacity as per mechanical volume.

API type oil water separator overflow sump of RCC construction of minimum capacity as per mechanical volume.

CT Blowdown reservoir of RCC construction with holding capacity as per mechanical volume

pH correction chamber of RCC construction.

UF filter water tank of RCC construction with PPG anticorrosive lining of 3.5mm overall thickness

Degassed water storage tank of RCC construction with inner FRP lining and holding capacity as per mechanical volume. External painting as per mechanical specification

Ferric Chloride Solution preparation tank of RCC construction with inside PPG lining of 3.5mm overall thickness

Lime Solution preparation tank of RCC construction with inside PPG lining of 3.5mm overall thickness

4.30.00 Fire Protection and detection system

4.30.01 All civil works for laying of fire water lines

For Fire protection & detection system, civil & structural works shall be as per the specific technical requirement. Fire Water pipes shall be taken on grade slab over RCC pedestals / in underground RCC trenches with removable RCC cover slabs as per the site requirements. In all areas, like Boiler, Power House building outside periphery, ESP, Switch Yard, Chimney, etc. pipes shall be placed inside the RCC trench with removable RCC cover for the paved areas and Fire water pipes in rest of the areas for the entire plants shall be on the RCC pedestals in general. The RCC pedestal shall be laid at intervals as stipulated in TAC. All civil works including the construction of Pedestals, RCC trenches with removable RCC covers shall be under the scope of contractor. Complete civil works of fire protection and detection work are covered in contractor's scope...

4.30.02 Fire water tank foundation

Separate tanks for Fire Water storage are required (as per CI-1.00.00, Sec-II of Vol-II-J). Tank shall have all provisions as per the process requirement. The foundation for Fire water tank shall be provided as per design requirements

4.30.03 Equipment Foundations

Different Equipment Foundations for Fire Protection and Detection System

Foundations shall be designed, detailed and provided for the following equipment for Fire Protection and detection system and auxiliaries as described below. This list is indicative only. Foundations for any other equipment / components as required for completeness of the system are also in the Contractor's scope.

- i) Hydrant pumps (motor driven)
- ii) Hydrant pumps (diesel engine driven)
- iii) Spray pumps (motor driven)
- iv) Spray pumps (diesel engine driven)
- v) Jockey pumps

- vi) Deluge valve House
- vii) Hose House
- viii) Booster Pumps
- ix) Foam Tanks
- x) Hydrant Stand Post

4.30.04 FIRE WATER PUMP HOUSE

- i) Fire water pump house shall be RCC framed structured building with RCC roof and fly ash brick masonry.
- ii) The pump house building shall accommodate fire water pumps and any other facilities as per system requirement. Safety norms shall be followed as applicable. RCC stairs up to the roof shall be provided.

4.30.05 FIRE WATER BOOSTER PUMP HOUSE

- i) Fire water Booster pump house shall be RCC framed structured building with RCC roof and brick masonry.
- ii) The pump house building shall accommodate fire water Booster pumps and any other facilities as per system requirement. Safety norms shall be followed as applicable. Access to roof shall be provided.

4.31.00 SWITCHYARD CIVIL WORKS

4.31.01 Switchyard Control Room

Switchyard Control Room shall be Two (2) storeyed RCC framed structure with RCC grade slab and Floors and RCC roof. Side claddings shall be of Fly ash Bricks.

Control room, offices, MCC & switchgear room, cable vault, Stores, Battery rooms, Pantry room, etc. shall be accommodated within this building maintaining all functional and / or operational requirements. Emergency exit stair shall be provided in addition to main staircase.

Rolling shutter, Door, Window, False Ceiling with under deck insulation, roof treatment and other finishes shall comply with Architectural specification. There shall be continuous hermetically sealed double glazing aluminium window for the control room on switchyard side.

Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. RCC stairs up to the roof shall be provided.

4.31.02

GIS Building in Switch Yard (Number shall be as per Electrical requirement)

GIS Building Shall be One (1) storeyed RCC framed structure with RCC ground Floor and RCC roof on metal deck. Roof beams shall be of structural steel. Side claddings shall be of Fly ash brick wall. Provision shall be kept for crane for handling of equipment. The building shall be provided for natural ventilation.

The FFL of GIS buildings shall be as per Electrical requirement Foundation for GIS equipment shall be provided. Cable trenches shall be designed and provided as per requirement.

Door, Window and other finishes shall comply with Architectural specification. Rain water down comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Access to roof through RCC stair shall be provided.

The GIS Building shall be provided as per the technological requirement. The Building shall be provided with Epoxy Floor Finishing as specified below:

FLOOR FINISHING SYSTEM:

2.2 mm Self Levelling Epoxy – Polyurethane (EPU) system

The specification of the flooring system shall be as below:

SURFACE CLEANING/REPAIR/LEVELLING:

Cleaning of surface free from dust, dirt, moisture & all foreign material from the floor. All damaged and deteriorated concrete shall be repaired with polymer concrete materials to restore sound condition. Concrete surface is checked for cracks, joints and pot holes. Control joints shall be filled in with suitable flexible polymer materials as per manufacturer's recommendation.

PRIMER: Providing and applying two component, high viscous, solvent free epoxy primer, having a volumetric mixing ratio of resin and hardener 1:1, to provide a DFT of around 200 microns.

SCREED: Providing and applying low viscous, high strength, epoxy based self levelling screed, to the desired thickness of 1000 microns. The layer is de aerated by spike roller to dislodge air pockets. Finished screed has compressive strength of 120-125MPa.

SELF LEVELLING TOP COAT: Providing and applying EPU based self levelling top coat, to yield a thickness of 1000 microns. The volumetric mixing ratio shall be 2:1.

The top coat shall have the following properties –

- Compressive strength - 60-70MPa

- Tensile strength -15–20MPa
- Elongation - 45-50%
- Flexural strength - 40–45MPa

CURING & PROTECTION: Allow flooring system to cure undisturbed for atleast 24 hours after application of final coat. All polymers require 7 days at room temperature to reach optimum design strength. Lower temperature extends curing times.

- Flexural strength - 40–45MPa

CURING & PROTECTION: Allow flooring system to cure undisturbed for at least 24 hours after application of final coat. All polymers require 7 days at room temperature to reach optimum design strength. Lower temperature extends curing times.

The materials shall be procured from standard manufacturers and got it approved by the purchaser before use.

4.31.03

Civil Works for Switchyard includes:

- Towers, girders, lightning masts and equipment supporting structures including proto type assembly etc.
- Foundations and supporting pedestals for towers, lightning masts, equipment supporting structures etc.
- Foundations and superstructures for Switchyard control room building and GIS building.
- Earthing mat, single lane rigid pavement roads and RCC drains in switchyard area including road / drain / trench crossings etc.
- All necessary embedments, inserts, supporting structures & supporting members as required etc.
- Cable trenches in switchyard and inside GIS Building, control room building including civil works for panel /equipment fixing etc.
- Stone filling to be considered for entire switch yard area. PCC layer below stone filling shall be properly sloped to drain the water to the drains surrounding the switchyard limits. Approach roads, drains and cable trenches shall be of RCC
- On all sides, 150 mm thick PCC Paving of grade M-20 over 230 mm thick Stone Boulder soling shall be provided from the switchyard fencing to nearest drains for draining the storm water

- ix) Switchyard shall be enclosed with chain link fencing with intermediate steel post & steel gates as per Electrical requirement.
- x) Not used.
- xi) Necessary civil works including RCC foundations for BR (Bus Reactor), LR (Line Reactor), ICT (Interconnecting Transformer) and Interbus Transformer (IBT) within the switch yard area shall be provided. RCC rail road shall be provided from the above transformers/Reactors to the Rail road. Smooth gradient in the rail road shall be maintained between the level differences as per the design requirements. Anchor blocks shall be provided at suitable locations.
- xii) Construction of RCC Oil Pit within the switchyard area as per the electrical requirement.

Design Criteria

Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to Grade IS: 2062 and duly galvanized conforming to IS: 2629 and IS: 4759. All joints shall be bolted connections. All bolts for connections shall be of 16 mm dia conforming to IS: 12427 and of property class 5.6 as per IS: 1367 (Part 3). Nuts shall conform to IS: 1363 (Part 3) of property class 5. Foundation bolts shall conform to IS: 5624 and property class shall be 4.6 as per IS: 1367 (Part 3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS: 802 "Code of practice for use of structural steel in overhead transmission line towers" shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200 m for design purpose.

Switchyard structures shall be designed for the worst combination following loads:

- i) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members).
- ii) Live loads
- iii) Wind loads
 - a) Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS: 802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (V_b) and terrain category as stipulated elsewhere in this specification.

- b) All other structures shall be designed as per IS: 456 / IS: 800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated elsewhere in this specification.
- iv) Seismic loads
- v) Temperature load
- vi) Loads due to deviation of conductor (gantries shall be checked for + 30 deg deviation in horizontal plane and + 20 degree deviation in vertical plane).
- vii) Loads due to unbalanced tension in conductor / wire.
- viii) Torsional load due to unbalanced vertical and horizontal forces.
- ix) Erection loads
- x) Short circuit forces including snap in case of bundled conductors etc.

Note:

- i) The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.
- ii) Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures.
- iii) Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.
- iv) The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.
- v) The distance between terminal and dead end gantry shall be taken as 200 meters.

Factor of Safety

Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition. For the design of towers, stipulations of latest version of IS 802 (Part 1 / Sec 1 & 2) shall be applicable.

Design consideration for Switchyard Equipment Support

- i) The supporting structure for BPI, LA & tariff metering CVT shall be comprised of grade YST:210 or of higher grade conforming to IS:1161 & shall be designed as per IS:806 "Code of Practice for use of steel tubes in general building construction".
- ii) Minimum diameter of the Pipe-type support for 400 kV structure shall be 250 NB.
- iii) The supporting structure for tariff metering CT & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS:2026 and shall be designed as per IS:802.

Special Design Consideration for Lightning Mast

Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.4 times the wind calculated on longitudinal/transverse side. Lightning mast shall be provided with minimum two nos. of platforms as per requirement and a cage ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900 mm. Live load of 300 kg/m² above platforms shall be considered for design of Lightning Mast.

Additional Design Criteria for Structures

- i) The design of RCC structures shall generally be carried out using limit state method of design as per IS: 456. The minimum grade of concrete shall be of RCC M30 as per IS: 456.

The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS: 802 and IS: 800. All materials shall be completely shop fabricated and galvanized.

All structural steel members including stub members, bolts, nuts, spring washers, etc. shall be hot dip galvanized after fabrication. Minimum section thickness shall be as per technical rule. Weight of zinc coating shall be at least 0.610 kg/m² and foundation bolts shall have heavier zinc coating at least 0.80 kg/m².

Cable Trenches

Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 150 mm above the finished paving level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits where provision shall be made for pumping. The precast covers shall not be more than 300 mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches

shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of comers of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 8 mm thick (o/p) chequered plate covers while external cable trenches shall have pre-cast RCC covers. However, the portion of the cable trench behind and sides of control panel shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500 mm, shall have wall thickness of minimum 150 mm with two layer reinforcement.

Stone Filling

Stone filling with 40mm downgraded BG metal shall be provided in entire switchyard area with thickness of 150 mm as per the electrical specification requirement. Below that 150 mm thick PCC of Grade M20 with 230mm (consolidated thick) layer of Stone boulders soling shall be provided. Before laying the Stone boulders soling, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed / soil sterilization chemical shall be procured from reputed manufacturer. The Contractor shall submit necessary details pertaining to the types of weeds found in the vicinity, anti-weed/soil sterilization such as manufacturer's name, their specification, test certificate etc. for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the Contractor at no extra cost to the Employer. The Contractor shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.

4.32.00 General Plant Illumination

4.32.01 Civil / structural works related to General Plant Illumination

The System description is detailed in Section VII of Volume II F2. All Civil and Structural Works related to General Plant Illumination System including Equipment foundations, panel foundations and all other related civil works are under the scope of Contractor.

All necessary Civil and Structural Works including excavation, backfilling, design, fabrication, erection, painting, cleaning up, inspection and testing etc. as per technical specification as required also under the scope of contractor.

Design, detailing and execution of foundations, Trenches etc. as necessary for the system including the design of Street light poles, flood lighting towers/poles/high mast considering all possible loads (DL, wind etc.) under the scope of contractor.

Any other equipment / components as required for completeness of the system; foundations of the same are also in the Contractor's scope.

4.33.00 Plant Buildings / Structures for FGD

Structures in FGD are discussed below. For detailed specifications, of FGD System, Mechanical Volume shall be referred to. FGD areas shall have suitable surface drainage facilities.

4.33.01 Junction Towers (JTs)

Over ground JTs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The super structure for JTs shall be of steel framed structure with adequate bracing arrangement. The ground floor and all intermediate floors shall be of RCC of Grade M30 and intermediate floors shall be over metal deck sheets and shall be finished with IPS (Indian Patent Stone) with metallic hardener having proper slopes for drainage. The roofs shall be of RCC covered with metal deck with water proof treatment and drainage slope. Parapet wall shall be provided as per the architectural specification. The side cladding shall be of 230mm fly ash brick upto 1m height and single skin, zincalume metal cladding over the brick work. Brick wall shall be inside face of sheeting with a lapping of 150 mm

JTs shall be provided with independent steel staircase with steps of Galvanised MS grating from ground to Roof. The clear width of the stair shall be minimum 1.2m. The tread shall be at least 275 mm and riser shall be uniform throughout the height and shall not exceed 150mm. However the codal regulations shall also be complied with. Continuous galvanized MS handrails vertical and horizontal shall be provided for the staircases with toe guard (150x6) for entire staircase and landing area

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All Junction Towers shall be provided with adequate number of windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside /outside of Junction Towers may have chequered plate floors with horizontal floor bracing.

Minimum clearance of 1.5m shall always be provided around any equipment / structure / pedestal inside the building.

Adequate floor washing arrangement shall be made for all JTs. Provision of floor dust collection and removal by chute shall be made. Deflection of JTs at conveyor entry level shall be within height/1000 across the conveyor & height/500 along the conveyor. While designing JTs necessary provision shall be made in loading for future conveyor to be housed inside JTs, as applicable.

Door, Window and other finishes shall comply with Architectural specification. DI Rain-water-down-comers of 150mm thick to be provided. Plinth protection, garland drains and approach road are to be provided.

4.33.02

Conveyor gallery and Trestles

On grade and over ground galleries shall be of enclosed type for adequate weather protection. The walkways for on-grade galleries shall be raised and they shall be made of concrete with skid proof finish. Overhead conveyor galleries shall be structural steel consisting of two girders braced at top and bottom and supported on trestles.

Walkway portion of over ground conveyor galleries shall be of chequered plate of 8mm thick with antiskid bar or expanded metal grating. Clear width of central and side walkways shall be as per Mechanical requirement with 3.0m clear height. For Single Conveyor gallery, both side Walkways shall be as per Mechanical requirement. The maximum span of standard gallery shall be 24 m unless higher span is necessitated due to site constraints which shall be subjected to the approval of Owner/Consultant. The galleries for double stream conveyors shall have one central walkway and two side walkways and single stream conveyors shall have two side walkways.

Galvanised MS Hand railings shall be provided as required. For Entire conveyor Gallery seal plate of minimum 4 mm thickness shall be provided so that a complete leak proof bottom shall be formed. The over ground conveyor galleries shall be designed for adequate ventilation and natural lighting.

Conveyor gallery having slopes greater than 8 degree, stepped walkways of chequered plates with nosing and toe guard shall be provided all along the conveyor. 10mm dia Tor anti-skid steel bars shall be provided @ 500 mm for inclined walkways below 8 degrees.

Suitable floor washing arrangement shall be made in the conveyor gallery with down comers.

In between Junction Towers / buildings four legged trestles shall be placed at a maximum interval of 100 m. The arrangement shall be such as to ensure that force in the longitudinal direction of conveyor gallery of length not more than 100 m shall be transferred to four legged trestle.

Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and movement.

End of conveyor gallery which shall be supported over Junction Towers, shall be so detailed that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to Junction Towers and vice-versa by providing sliding supports.

All RC trestle pedestals shall be raised to minimum (+) 0.500 m above FGL. Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels,

trenches, drains, etc. The minimum clearance over road and railway crossing shall be 8.0 meters.

Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girder shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans.

Roof truss shall be provided at upper node points of latticed girders to form an enclosure. The gallery shall as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position.

The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

Conveyor gallery shall have permanently colour coated Zinalume sheet covers on roof and both sides. However in roof, a panel of minimum 1.5mx1.5m area at about 6.0m c/c shall be provided with 4mm thick translucent sheets of polycarbonate material for natural lighting with MS grill support.. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. The bottom level of edge of roof sheeting shall match with bottom of slit level to prevent rain water entry. Adequate provision of openable aluminum windows shall be kept on both sides of conveyor gallery shall be provided with MS safety grills inside. Cable rack shall be provided to suit the requirements of approved Mechanical GA of conveyer gallery.

Crossover with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 m intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

Conveyor gallery structure shall be designed considering both conveyors operating simultaneously.

Conveyor gallery and supporting trestles located between transfer houses / buildings shall be arranged in any one of the following ways. Allowable vertical deflection of gallery shall be restricted to span/450. For trestles and junction towers, it shall be restricted to height / 1000 across the conveyor direction and height / 500 along the conveyor direction.

4.33.03

Lime stone Crusher House

Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC over metal deck sheet on structural steel beam. Side cladding shall be Fly ash brickwork up to 3.0m height from FFL above that metal cladding as per architectural specification. Roof shall be given adequate slope for drainage. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification. Proper arrangement shall be provided to convey the rain water through gutter of matching colour and down comers as specified elsewhere.

Adequate number of aluminium glazed windows shall be provided as specified elsewhere. Wherever monorails are projecting outside for lifting of equipment, hollow metal sliding flush doors shall be provided. Main entrance doors shall be electrically operated rolling shutter adequately sized to carry equipment inside. Other doors shall be of hollow metal flush doors. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall be of RCC. Intermediate floor shall be RCC over metal deck supported on steel beams. Handrail shall be provided around all openings with kerb plates/concrete. Minimum clearance of 1.5m shall always be provided around any equipment / structure / pedestal inside the building.

Two steel staircases shall be provided one inside and one outside, both of structural steel. Rack and pinion elevator shall be provided. Machine room of elevator floor and roof shall be of RCC. Side cladding of M/C room shall be of colour coated sandwiched cladding system. An RCC kerb wall of 300 mm shall be given around the floor and 100mm kerb around openings. M/C room shall be given adequate slope for drainage purposes. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification with 150mm dia DI down comers. Main door to M/C room shall be of hollow metal flush door. Adequate ventilation shall be given using aluminium glazed window. Toilet shall be provided in the Crusher house. Elevator pit shall be kept at least 500 mm above general grade level to prevent flooding. A sump shall be provided inside the pit to collect and pump out water. Sump shall be given with access ladder.

Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth beams. Top of the pedestals for the columns shall be above finished ground floor level as specified elsewhere.

Side cladding shall be with permanently colour coated profiled double skin zincalume steel sheets with insulation. However, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting. The lower portion of side cladding for a height of minimum 3m height above finished floor level shall be of 230mm thick fly ash brick wall plastered on both faces. Grade slab shall be of RCC. Permanent metal decking shall be used for support of RCC floor slabs. Within this building cubicles are to be provided for resting room of operators and these shall be constructed with

one brick thick fly ash brickwork having both sides plastered and RCC roof slab. Vertical bracings shall be provided only on four sides along the periphery. No vertical bracings between columns shall be allowed inside the floor.

Plinth protection, garland drains and approach road are to be provided.

Necessary provision of hoisting and handling arrangements shall be as per technological requirement.

Below the monorail projection, RCC paving in M30 5m wide upto road shall be laid at the grade level for loading unloading.

The entire crusher house shall be designed as per approved mechanical drawing.

Crusher Foundation

The crusher shall be supported on M35 grade RCC deck slab mounted on vibration isolation system comprising springs and viscous dampers, which in turn shall be supported independently on ground-supported RCC frame structure. The crusher foundation shall be made isolated from crusher building & this shall suit to process requirements. Crusher foundations shall be kept isolated by providing 75 to 100 mm gap all around at crusher floor level as per process requirements. The vibration isolation shall be done by providing inertia block with anti-vibration pads. These pads shall be suitably procured with respect to crusher manufacturer's specifications.

(or)

The crusher shall be supported on M35 grade RCC deck slab mounted on vibration isolation system comprising springs and viscous dampers, which in turn shall be supported on suitably designed steel floor beams to avoid transmission of vibration. Steel beams shall have the limiting deflection as per VIS, OEM recommendation.

Detailed dynamic analysis shall be done for top deck of limestone crusher together with springs & dampers and natural frequencies & amplitudes of vibration shall be determined. A mathematical model of top deck shall be formulated with three dimensional beams, plate, and finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffness. The mass of the machine together with that of the top deck shall be considered for the analysis. Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out for the unbalance forces generated during operating condition using a sinusoidal forcing function. Unbalanced forces as given by the manufacturer shall be used for this purpose.

Ultrasonic pulse velocity (UPV) test shall be carried out for crusher foundation to ascertain the homogeneity and integrity of concrete. Testing shall be done as per IS: 13311 (Part-1). The defects shall be rectified by using cement /

epoxy grout etc.

Isolation Efficiency

The vibration isolation system shall be designed for about 90% isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction of achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly foundation isolation efficiency criteria and de-coupling required.

The bending mode frequency of the top deck shall be atleast 20% above the operating speed.

Unbalance Forces

- i) Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.
- ii) Balance quality grade Q40 as per VDI 2060-1966.
- iii) One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non-drive end of the crusher.
- iv) Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non-drive end of the crusher.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions:

Operating speed of 750 RPM:

- i) 150 microns for an unbalance force arising out of balance quality grade Q40 as per VDI 2060.
- ii) 300 microns in case of a one hammer broken condition.
- iii) Amplitudes need not be checked for a three hammer broken condition.

Operating speed of 450 RPM:

- i) 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI-2060.
- ii) 300 microns in case of a one hammer broken condition.
- iii) Amplitudes need not be checked for three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM, the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

Transient Resonance

Transient resonance, which may occur during the start-up or coasting down condition of the crusher, shall be checked and the amplitudes in such a condition shall not exceed one – and half times those at operating speed for each design condition.

Strength Criteria

The following criteria shall apply for the design of top deck:

- i) Dead loads, live loads, seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall be considered for design.
- ii) Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the crusher. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together.
- iii) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.
- iv) Working stress method shall be used for the design of RCC deck. In survival condition, 10% overstressing may be permitted.
- v) The RCC top deck shall be atleast of M35 grade of concrete as per IS:456.
- vi) Fatigue need not be considered for the three hammer broken

condition.

- vii) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall not exceed the value specified by the manufacturer.
 - viii) Loss of contact of foundations at founding level shall not be allowed for any combination of loads.
- Door, Window and other finishes shall comply with Architectural specification.

DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule.

4.33.04 **Limestone Storage Building/Shed**

This building shall be single storey steel structure of framed / braced design. Roof shall be colour coated zincalume metal slopped roof truss. Side Cladding shall be of Fly ash brick wall upto 3.0m and colour coated single skin zincalum sheet metal cladding above brick wall.

RCC ground floor slab shall be provided as per Architectural /technical rule..

Steel door and Al glazed windows with Al grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

Plinth protection, garland drains, DI down comers with gutters and approach road are to be provided.

RCC paving shall be provided both inside and outside the storage building as per the technological requirement. Inside the building the floor shall be finished with 50mm thick metallic hardener floor finishing.

4.33.05 **NOT USED**

4.33.06 **Limestone Grinding Building**

This building shall be single storey steel structure of framed / braced design. Roof shall be RCC on metal deck sheet. Crane Supporting Structures shall be provided including Supply and Erection of Crane of capacity as per the Technological Requirement in the slurry preparation area. Monorail of required capacity as per technological requirement shall be provided. Side Cladding shall be of Fly ash brick wall upto 3.0m and single skin colour coated zincalum sheet metal cladding above brick wall. Access to roof through stair shall be provided. Roof shall be provided with RCC Parapet of 125mm thick and 1.0m height.

RCC ground floor slab shall be as per Architectural /technical rule.

Steel door and AI glazed windows with AI grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Floor finishing shall be of 50mm thick minimum with metallic hardener. RCC paving shall be provided both inside and outside the storage building as per the technological requirement.

4.33.07 **NOT USED**

4.33.08 **Absorber Pump & Oxidation air blower House**

These buildings shall be single storey steel structure of framed / braced design. Roof shall be RCC on metal deck sheet. Crane Supporting Structures shall be provided including Supply and Erection of Crane of capacity as per the Technological Requirement. Side Cladding shall be of 230mm Fly ash brick wall. Access to roof through stair shall be provided. Roof shall be provided with RCC Parapet of 125mm thick and 1000mm height.

RCC ground floor slab shall be provided as per Architectural /technical rule.

Steel door and AI glazed windows with AI grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

150 mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Floor finishing shall be of 50mm thick with metallic hardener.

4.33.09 **Electrical Switchgear & Control Building / FGD Main Building**

This building shall be two storeyed RCC framed structure. Floor and Roof shall be RCC. Side Cladding shall be of 230mm Fly Ash Bricks. Access to roof through RCC staircase shall be provided. Roof shall be provided with RCC Parapet of 125mm thick and 1000mm height.

The layout of FGD Electrical & Control Building with hoisting facilities shall be as per technological requirement.

All air-conditioned areas, shall be provided with the suspended aluminium false ceiling system (details specified elsewhere) with under deck insulation.

Adequate aluminium doors and windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing.

Aluminium glazed partitions for control room are to be provided.

False ceiling, AC & ventilation ducts, cable galleries, inserts, concealed/conduit wiring as per technological requirements are to be provided. RCC stair case shall be provided from GF to Roof. Roof shall be provided with RCC Parapet of 125mm thick and 1000mm height.

Door, Window and other finishes shall comply with Architectural specification.

150mm dia DI Rain-water-down-comers to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Ground floor of the building shall be of RCC as per Architectural /technical rule.

For Transformers outside control room, fencing, gate, soling & paving, drainage system are to be provided.

4.33.10 **Gypsum De-watering House**

This building shall be a three storeied (G+2) steel structure of framed / braced design. Intermediate floors shall be RCC. Roof shall be colour coated zincalume metal slopped roof truss. Layout and provisions shall be as per the technological requirement. Dry gypsum from this building shall be transported to gypsum dumping shed through belt conveyors. Crane Supporting Structures shall be provided including Supply and Erection of Crane of capacity as per the Technological Requirement. Side Cladding shall be of 230mm Fly ash brick wall upto 3.0m and single skin colour coated zincalume sheet metal cladding above brick wall.

RCC ground floor slab shall be provided as per Architectural /technical rule..

Steel door and AI glazed windows with AI grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

150mm dia DI Rain-water-down-comers with gutters to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Floor finishing shall be of 50mm thick with metallic hardener.

4.33.11 **Gypsum Storage Building/shed**

This building shall be single storey steel structure of framed / braced design. Roof shall be colour coated zincalume metal slopped roof truss. Crane Supporting Structures shall be provided including Supply and Erection of EOT Crane of capacity as per the Technological Requirement. Side Cladding shall be of 230mm Fly ash brick wall upto 3.0m and single skin colour coated zincalum sheet metal cladding above brick wall.

RCC ground floor slab for entire area with retaining wall (if any) shall be provided as per system requirement. The other features shall be as per Architectural requirements.

Steel door and Al glazed windows with Al grill protection, and rolling shutter (electrically operated with gears), shall be provided.

Door, Window and other finishes shall comply with Architectural specification.

150mm dia DI Rain-water-down-comers with gutters to be provided. Plinth protection, garland drains and approach road are to be provided. Toilets are to be provided in the building as per the technical rule. Floor finishing shall be of 50mm thick with metallic hardener.

4.33.12 **Miscellaneous Items**

The RCC Sumps / Liquid retaining Tanks shall be designed as Un-cracked section as **Tightness class 3 in accordance with IS: 3370 (Latest Revision).**

Design, detailing and execution of equipment foundations, Trenches etc. as necessary for the system are under the scope of contractor.

Any other equipment / components as required for completeness of the system; foundations of the same are also in the Contractor's scope.

4.34.00 **Brief Design Consideration for Some Special Structures**

Induced Draught Cooling Tower

The civil works for cooling tower (both main and auxiliary) are related mainly to following areas, but not limited to:

1). **Cooling tower**

a) **Cooling Tower Basin, Sump and Duct**

The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M35 grade as per IS:456). The floor of the basin shall be sloped to minimum 1 in 80 towards outlet. The required slope shall be achieved by either screed concrete of 1:2:4 having minimum thickness at edge as 25mm or by suitably adjusting base/floor raft. Galvanized handrail 1000mm high shall be provided all round the cooling tower basin and sludge sump pit.

The bottom 500 mm of this railing shall also have galvanized 3 mm thick wire mesh with opening size of 50mm grid to avoid ingress of leaves vegetation and debris into the basin.. The basin shall be tested for water tightness as per IS:3370.

Basin floor slab shall be designed to rest on raft/mat/pile

foundation including support structures. The stiffness of the subsoil shall be taken into account. The founding level of the raft/mat shall be either on virgin ground level or shall be placed at higher level only after scooping out filled up soil up to virgin ground and then filling back with well compacted sand (95% of relative density) up to the founding level of the raft/mat. The contractor shall ascertain the safe bearing capacity of the stratum/pile capacity at the founding level and may adopt the same subject to Owner/Consultant approval

Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for uncracked section.

The end of the outlet channel shall be provided with 230 mm wide and 6 mm thick PVC water stop all round the cross section of channel. The outlet channel shall be covered on top with removable precast concrete slabs with G.I. handrail on both sides of the channel.

Hot water duct around cooling tower shall be below ground.

b) Super Structure of Cooling Tower

Beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M30 (minimum) as per IS: 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.

The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1:120(min). The slope shall be provided with screed concrete (1:2:4). Deck slab and all other over ground platforms shall be provided with galvanized GI hand rails (vertical post as well as horizontal pipes) and with galvanized toe guard all around. Suitable arrangement for drainage of rain water to be provided.

c) Cells, Distribution System and Stack

Cooling tower cells shall consist of RCC columns, beams and walls. Hot water distribution channel shall also be of RCC. Cell division partition walls may be of Cast-in-Situ RCC or precast concrete blocks.

Hot water channel shall be covered with suitably designed precast/ cast-in-situ concrete slab. Wherever flow control valves are located over hot water basin, there shall be placed over precast concrete covers/concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150mm. The fan stack shall have two layers of

reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c. External surfaces of cooling tower peripheral cladding walls and fan stack shall be painted with two or more coating of waterproof cement paint of approved shade, make and colour.

d) **Staircase**

Two (2) numbers RCC staircase for approach to fan deck for each cooling tower shall be provided.

e) **Steel Structures**

All mild steel parts of structures used in cooling towers shall be hot double dip galvanized for a very long period of maintenance of more than 20 years. The minimum coating shall be 610gm/sq.m and shall comply with relevant IS codes. Galvanizing shall be checked and tested in accordance with IS:2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints, Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of AISI 304 or SS 316 or equivalent as approved by OWNER. For painting of steel members in overhead cable trestle refer elsewhere in this specification.

f) **Grade of concrete**

All RCC work to be done under this specification, unless specified otherwise, shall be design mix (controlled) concrete of grade M30 of IS: 456. Water-cement ratio shall not exceed 0.45.

i) All other civil works required to make installation of cooling tower complete, including the connection of hot water duct.

ii) Dedicated Switchgear building (Two Storied RCC) shall be provided for each IDCT near the IDCT as per system requirement

2). **Design Criteria**

R.C.C Structures

The design of all RCC structures under induced draught cooling water system shall be carried out using Working Stress Method of design as outlined in IS: 456 & IS 3370 (Part I to IV). Minimum clear cover to all RCC structures under induced draught cooling water system shall be

50mm. Design of structures such as staircase etc. which are not in contact with water/ water spray/ moist air shall be carried out adopting material stresses as given in IS: 456. However, design of structures such as columns, beams, fins, walkways, slabs, etc. shall be carried out as per IS:3370. In addition, a crack width check on sections designed as above shall be carried out. The crack width (calculated as per provisions of IS 456/IS:3370) shall not exceed 0.1mm. The design of liquid structures like C.W. basin, sump, outlet channel, hot water distribution channel shall be as given herein below..

- (a) Design of CW Basin wall, sump, column foundations, outlet channel, duct, sludge pit, Hot water distribution basin/ Hot water Channel shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**. Both water face and soil face of above liquid retaining structures shall be designed as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**. The allowable stresses for concrete and steel shall be as per IS: 3370 (Part-I to IV). The C. W basin, ducts, sludge pit, etc. shall be designed for the following conditions:

- (1) Water filled inside up to the designed level and no earth outside.
- (2) Earth pressure plus 2.5 T/m² surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

Wherever the foundation raft is same as the CW basin slab, the foundation shall be designed as uncracked section (both water face and soil face). However, if the foundation slabs are provided at different level requirements, the CW basin slab shall be designed as uncracked section (both water face and soil face). The structures below CW basin slab i.e. Foundation slab/raft, basin supporting columns/walls shall be designed as per working stress method.

- (b) For uplift due to ground water table, the basin slab shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for all construction phases & operating stage with no water inside. The provision of flap valve/ pressure relief valves is not permitted. The factor of safety against uplift shall be as per IS: 3370.
- (c) Fan deck shall be designed for rolling loads due to movement of equipment during Installation/ maintenance operation.
- (d) All RCC structures shall comply with durability requirements for

severe exposure conditions as per IS: 456.

Individual Outlet Channel leading to CW Channel

RCC cooling water channels shall be of rectangular shape and designed as a water retaining structure as **Tightness class 3 in accordance with IS: 3370 (Latest Revision)**. Depth of channels and width of channels shall be in-line with CW Channel. These branch channels shall join together and form common channel to the fore-bay to the pump house. Dimension of the channels shall be decided on the basis of the quantity of water to be carried by the channel and shall be in line with approved SUMP MODEL STUDY & CFD analysis. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above finished ground level with suitable galvanised MS pipe hand railing on either side.

3). Steel Structures

- 1). All welds shall be subject to 100% visual examination.
- 2). Dye penetration test on welds shall be carried out.
- 3). Welding shall be done as per approved procedures and by qualified welders.

Galvanizing shall be checked/ tested for all tests as per IS: 2629. For all steel structures outside cooling towers, painting shall be as per details specified elsewhere in this specification.

4). Loading

For consideration of loads on structures and load combinations IS: 875 (Part 1 to 5) –Code of Practice for design loads other than Earthquake) for Buildings and Structures shall be followed..

Live Loads

The following live loads (minimum) shall be adopted for the design of buildings, structures:

a	Roof / Fan deck	500 Kg/Sqm
b	RCC Floors	500 Kg/Sqm
c	Stair, landings	500 Kg/Sqm
d	Chequered & Grating floor	400 Kg/Sqm
e	Culverts and its allied structure	Class 'AA' loading (wheeled and tracked both) and to be checked for Class 'A' loading as per IRC

standards.

- | | | |
|---|---|--|
| f | Basin, sump | Earth pressure in submerged condition water pressure as applicable and additional surcharge load of 2.50 T/Sqm |
| g | Covers for H.W. channel/
H.W. distribution basin | 500 Kg/Sqm |
| h | Walkways inside cooling
towers | 500 Kg/Sqm |
| i | Underground pipes and ducts | Earth pressure and surcharge load of 2.50 T/Sqm |
| j | Cover of cable / pipe
trenches | 500 Kg/Sqm or as per (e) above as the case may be. |

4.35.00 HYDROGEN GENERATION PLANT

Hydrogen generation building (with cylinder storage facility) shall be RCC/Steel frame with fly ash brick masonry with jally. This building falls under hazardous building category. The entire building campus shall be properly fenced to prevent unauthorized ingress or egress. Safety norms shall be followed as applicable. Facilities for the staff shall be provided as applicable.

Construction of the Hydrogen generation plant building in compliance with Indian Explosive Act and other statutory regulations governing the building.

All equipment foundations associated civil/structural works and technological structures to fulfill the technological requirement are in the scope of the Contractor. Payment of necessary license fee only to the State/Central Govt. authority for obtaining statutory approval will be borne by the owner. However facilitation for obtaining statutory approvals is in the scope of contractor. Owner shall support by way of giving letters etc. for obtaining approvals for the above.

4.36.00 TERMINAL POINTS

1) Ash dyke

- a) Approach/ Inspection road (including grading) along the ash pipes from the main road up to the ash dyke , inspection road around the ash dyke toe, Ramps, Inspection road at the top of bund and roads near Ash dyke for the inspection of Ash pipes are under scope of Owner .

- b) Where ever ash pipes to be laid by the Contractor crossing the roads, RCC Box culverts (designed as per loads mentioned in clause 3 of Volume G1 Section –II) shall be provided by the contractor and road shall be rectified by the contractor after the construction of culvert.
- c) All Ash Pipe support at GL / Pipe rack above GL from ash slurry pump house up to the ash dyke including pipe supports for the garlanding pipes are under the scope of the contractor.
- d) Pipe support and foundations for the raiser pipes to be routed on the bund up to the ash dyke discharge points including Laying of pipes with bed concrete of 200 mm and covering entire ash pipes with minimum 200 mm PCC fill for crossing the inspection roads (above the bund) from the garlanding slurry main pipes are in the scope of Owner. Necessary input for construction of the ash pipe supports including number of pipes, ash slurry pipe load, no. of discharge points, etc will be provided by contractor to the Owner / ash dyke contractor. However, the raiser ash slurry pipes shall be provided by the contractor up to the discharge point.
- e) Contractor shall utilize the existing road along ash pipe route as approach /inspection road for ash pipes. If there are no roads along the ash pipe route, new approach /inspection road for ash pipes shall be laid by the contractor as per specification mentioned elsewhere.

2) Raw water intake system

- a) For Terminal point for Intake pipe near RWR, refer relevant Mechanical volume. From the terminal point upto the discharge at RWR including pipes, specials, supports and foundations are under the scope of the contractor.
- b) Over flow drain from RWR shall be connected to Bhedan River through RCC Drains including RCC Box culverts crossing the roads are under the scope of the contractor.

3) Roads

- a) The plant main RCC roads shall be extended 10 m beyond all the gates.

5.00.00 DOCUMENT SUBMISSION

Design and Construction documents pertaining to all Civil, Structural and Architectural works that shall be required to be submitted to Owner for their approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the contractor of his responsibility for any errors and fulfillment of Contract requirements.

5.01.00 Design Document

Design Document shall comprise Mechanical/Electrical input Drawings,

design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings.

Design calculations and drawings shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. The Contractor shall submit approved GA drawings along with design documents, design drawings for comments/approval of the Owner/Consultants. On final approval of the drawing and design, Contractor shall submit the drawing with soft copy in CD each to the Owner and consultant for distribution. For number of design documents, design drawings & GA drawing to be submitted, contractor shall refer to section VI of Vol.-IIA.

5.02.00

Construction Document

Based on approved design drawing, detailed drawings for construction shall be prepared by the contractor. For reinforced concrete structures and foundations, approximate quantity involved (both reinforcement and concrete in grade wise) in approved format shall accompany each detailed civil drawing. However bar bending schedule can be prepared based on the approved civil drawing and submitted once design drawing is approved. For structural steel work the detailed drawing shall have schedule of structural members with approximate quantity of steel involved. The contractor shall prepare detailed fabrication drawing along with bill of materials.

All detailed drawings/ fabrication drawings as decided by Engineer for all structures along with bar bending schedule/bill of materials need be furnished to Owner/Consultants at construction site for their review and approval.

Upon approval, each drawing along with soft copy in CD shall be submitted to the Owner and Consultant for their distribution. Procedures for submission and approval of Construction Documents other than stated above have been mentioned elsewhere in this specification. For number of construction drawings/Fabrication drawings to be submitted, contractor shall refer to section VI of Vol.-IIA.

5.03.00

As Built Drawings

"As-built" drawings shall be prepared by the Contractor after completion of construction / erection incorporating all the changes, if any, done on Engineer's instruction/approval. In case of any discrepancy in the number of prints and CD to be submitted for Design, Construction documents and As-Built drawings mentioned elsewhere in the specification, stipulations made here shall prevail.

6.00.00

LAYOUT

Before starting the work, the contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and benchmark. If the contractor uses the grid, benchmark and reference pillar made by other agencies, he shall coordinate with that Agency.

and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and benchmark, which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification / modification necessary. No complaint shall be entertained at a later stage. The contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labour for checking the detailed layouts and levels. The contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The contractors shall take into account the cost of these in quoting their price.

7.00.00 WORKSMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those, which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lining and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. Necessary inserts / embedment in buildings/structures shall be provided as per the technological requirements. In addition to the requirement specified above, if the bye- laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such temporary work shall have the prior approval of the Engineer, but the contractor shall be responsible for proper strength and safety of the same. All temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and

re-erection, if required, shall be carried out by the contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the contractor.

9.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with other structures. Necessary changes on this account shall be made by the contractor without any extra cost to Owner.

10.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all-important items of work.

ANNEXURE-I

**LIST OF CIVIL FIELD QUALITY ASSURANCE LABORATORY APPARATUS
(MINM REQMNNT)**

SL NO.	DESCRIPTION	QTY
1	Cube moulds - 150 mm (ISI marked)	144
2	Cube moulds - 70.6 mm	18
3	Cube moulds - 50 mm	9
4	Cylindrical moulds – 300mm long 150mm dia	18
5	Beam mould – 700mmX150mmX150mm	18
6	Cube testing machine with two dial gauge and brick plate attachment	1
7	Digital thermometer - 200°C	6
8	Electrical oven	1
9	IS sieve set – 75 μ , 150 μ , 300 μ , 600 μ , 1.18 mm, 2.36 mm, 4.75 mm, 6.3 mm, 10 mm, 12.5 mm, 16 mm, 20 mm, 22.4 mm, 25 mm, 31.5 mm, 40 mm, 50 mm, 53 mm, 63 mm, 80 mm, 90 mm, 120 mm, 125 mm, pan (24 nos. per set)	1 Set
10	Measuring cylinder (glass) 50 ml, 200 ml, 500 ml	2 each
11	Physical balance Digital 10 kg capacity L.C. – 1 gm	1
12	Platform balance – Digital: 200 kg capacity	1
13	Pycnometer	2
14	Slump cone with tamping rod	8
15	Specific gravity bottle – 50 ml	2
16	Air entrainment meter capacity – 0.005 cum	2
17	Casagrande apparatus	1
18	Core cutter with collar and rammer	16
19	English type trowel	12
20	Hygrometer with thermometer	1
21	Impact testing machine	1
22	Le-Chatelier apparatus with water bath	1
23	Measuring cylinder (plastic) 50 ml, 100 ml, 200 ml, 500 ml	1

SL NO.	DESCRIPTION	QTY
24	Modified Proctor test apparatus	1
25	Length gauge	1
26	Penetrometer for mortar test	1
27	Moisture meter	1
28	pH meter	1
29	Sand replacement method apparatus	2
30	Screw gauge	2
31	Spatula	8
32	Standard Proctor test apparatus	1
33	Standard sand grade 1, 2, 3	500 kg each
34	Stop watch - Digital	1
35	Thermometer ordinary 50°C	10
36	Thickness gauge apparatus	1
37	Vernier calipers - Digital	1
38	Vicat apparatus	2
39	Weigh Boxes	4
40	Cylindrical measures: - capacity 0.01 cum, Dia (l) – 250 mm, Height – 280 mm, (l) with tamping rod as per IS 1199.	1



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha**

VOLUME: II-G/1

SECTION - II

**SPECIFIC DESIGN REQUIREMENTS
[CIVIL]**



Development Consultants Pvt. Ltd.

**Vol. II-G1/Section-II
Specific Design Requirements [Civil]**



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VOLUME: II-G/1

SECTION-II

**SPECIFIC DESIGN REQUIREMENTS
[CIVIL]**

1.00.00 INTRODUCTION

This section outlines the followings:

- a) A brief description of Soil Characteristics.
- b) Design considerations for Reinforced Concrete Structures.
- c) Design considerations for Foundations.
- d) Roads.

2.00.00 GEO-TECHNICAL SYSTEM

Detail soil investigation, as required, to be carried out for foundation design of various facilities.

Soil characteristics and parameters to be adopted in final design, the contractor is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required. The contractor shall conduct all the Field and Laboratory tests as mentioned in Vol-II-G2A – Section: II

It should be noted that nothing extra (both time & cost) whatsoever on account of variation between soil data annexed in this specification and that found by detailed geotechnical investigation to be carried out by contractor shall be payable.

The contractor shall use Geotechnical recommendations available in the tender document for various locations, depths and widths for reference for estimation purpose. Moreover, contractor is at liberty to carryout suitable number of borehole tests at site to assess the Net Safe Bearing Capacity values / Pile capacity for design of foundation prior to quote. After contract award, the contractor shall conduct detailed Geo-technical investigation. After completion of detailed Geo-technical investigation, the draft Geo-technical investigation report shall be submitted to owner/consultant for review/Approval. During the review/Approval, The recommendations furnished by contractor will be compared to the recommendations available in the tender document for various locations and depths. During the review, owner/consultant will offer their suggestions/remarks on the contractor's draft Geotechnical investigation report, If any. The design, type, size, depth of the foundation / pile, Net safe bearing capacity / Pile capacity values shall be based on the approved soil investigation report of the Contractor/Owner's soil recommendations(Available in the Tender document) whichever is conservative.

The design of foundation open/ pile shall be carried out by Limit State or working stress method as per the provisions of IS-456 / IS-2911 & other applicable IS codes.

Contour plan details & approximate grade levels will be supplied with contract drawing along with plant +/- 0.0m & UTM co-ordinate.

Technical specification for Geotechnical Investigation presented in Vol-II-G2A – Section: II to be referred.

3.00.00

LOADS

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements.

Before proceeding with the submission of civil & structural design of structures for approval, the contractor shall get the approval for the loads not pertaining to Civil & Structural (such as technological structures, mechanical equipment & supports, electrical equipment & supports, C&I equipment & supports, other miscellaneous equipment & Supports, etc.) from respective mechanical / electrical and C&I divisions. Civil & structural design & subsequent Civil/Structural drawings shall be reviewed by the Client/Consultant only after the approval of loads/load data as mentioned above.

Any structure, which carries Indian Railway Loading or is situated in vicinity of Railway lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc.

All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

a) Dead Loads

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, Ash storage bins shall be measured at full capacity for this purpose. The piping loads, Cable tray loads, Hung loads and the contents of tanks, silos, hoppers and bins shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift..

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials	Unit weight
Plain cement concrete	: 24.0 kN/cum
Reinforced cement concrete	: 25.0 kN /cum
Structural steel	: 78.5 kN /cum
Brick work	: 19.0 kN /cum
Cement plaster	: 21.0 kN /cum
Floor Finish	: 24.0 kN /cum
Coal	: 12.0 kN /cum
Fly Ash	: 16.0 kN /cum
Bottom Ash	: 16.0 kN /cum

For R.C.C roof wherever Solar panels are placed: DL of Solar panel shall be considered as per Manufacturer recommendation. In addition to other DL specified above

b) Live Loads

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. If actual expected load is more than the specified minimum load, then actual load is to be considered. Special use areas shall be investigated and loading revised upward as necessary.

Hung loads shall be based on minimum loading equivalents of 1.0 kN/sq.m for piping and 0.5 kN/sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

SI No	Building/Structure	Live Load
i)	All Buildings	
	a). Roofs	
	Inaccessible roof (Flat)	1.5 kN/sq.m+ hung loads, if any + 0.5 kN/sq.m(dust load).
	Accessible roof where equipment are placed	5 kN/sq.m+ hung loads, if any+ 0.5 kN/sq.m(dust load).
	Accessible roof Accessible roof Without equipment , and roofs with solar panel without any equipment	1.5 kN/sq.m+ hung loads, if any + 0.5 kN/sq.m(dust load).

SI No	Building/Structure	Live Load
	Inclined roof	As per IS: 875 (Part 2)
	b) Stairs, Balconies & Platforms	5.0 kN/sq.m
	c) Corridors	5.0 kN/sq.m
	d) Removable gratings, chequered plates, walkways etc	5.0 kN/sq.m
	e) Office, Laboratory, Conference rooms and other non-plant areas etc.	5.0 kN/sq.m
Note: Dust load values mentioned above shall be considered along with dead load while calculating lump mass for seismic load combinations		
ii)	Bunker Building	
	a) Ground Floor	25.0 kN/sq.m
	b) Bunker Feeding Floor	15 kN/sq.m+ hung loads + 0.5 kN/sq.m(dust load).
iii)	Power House Building	
	a) Ground Floor Unloading Bay	50 kN/sq.m
	Other areas	25 kN/sq.m
	b) Mezzanine Floor	15 kN/sq.m plus hung loads
	c) Operating Floor Equipment Lay-down Area	35 kN/sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
	Rotor Removal Area	50 kN/sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher. Rotor removal area beams shall also be checked for half the rotor load at the center of the beam

SI No	Building/Structure	Live Load
	Other Areas in Turbine Hall	25 kN/sq.m plus hung loads
	All other Areas in Operating Floor except Turbine Hall	15kN/sq.m plus hung loads
	d) Cable Spreader Floor	7.5 kN/sq.m plus hung loads
	e) All other floors	10 kN/sq.m plus hung loads
	f) Due to anchoring of conductors on any "A" row column	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Shielding Wires) or Actual load furnished by equipment supplier.
iv)	Auxiliary Buildings	
	a) Ground Floor	10 kN/sq.m
	b) Cable Spreader Floor	7.5 kN/sq.m
	c) Pump House Operating Floor	15kN/sq.m/ As supplied by Pump manufacturer, whichever is higher
	d) Office Floor	5 kN/sq.m
	e) Switchgear room	15 kN/sq.m
	f) All other Floors	10 kN/sq.m
v)	Non-Plant Buildings	
	a) Floors with equipment	10 kN/sq.m
	b) All other floors	5 kN/sq.m
vi)	Coal Handling structures	
	a) Flat accessible roofs	1.5 kN/sq.m+ 1 kN/sq.m dust load.
SI No	Building/Structure	Live Load

	b) Flat inaccessible roofs	0.75 kN/sq.m+ 1 kN/sq.m dust load
	c) Inclined roof	In accordance with IS 875 For live load + 0.25kN/sq.m For dust load.
	d) All TPS and Crusher house floors	7.5 kN/sq.m
	e) Switch gear and MCC floor	15 kN/sq.m
	f) Walkways of Gallery	3 kN/sq.m or a concentrated load of 2 kN at center + dust load of 1 kN/sq.m

Note: Dust load values mentioned above shall be considered along with dead load while calculating lump mass for seismic load combinations.

vii) Underground Structures/Trenches/pits

Minimum surcharge shall be 20 kN/sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/sq.m whichever is greater. In Boiler area, Power House area and other outdoor areas in BTG area, the minimum surcharge shall be 20 kN/sq.m.

viii) Covers for Trenches / Channels

At road crossings and entrance of the buildings wherever vehicle/crane movement expected, the covers shall be designed for vehicular movements as per IRC standards.

Trench cover at entry to building and road crossings shall be designed for live load of 100 kN at centre. Trench cover at other location shall be designed with a surcharge of 15 kN/m² or a concentrated load of 500kg at centre which is worst.

ix) Roads

Design of roads shall be in accordance with Indian Road Congress standard.

x) **Road Culverts and its allied structures including Road Crossing of Trenches.**

At all road crossings RCC box culverts along with manholes on both sides shall be used. Such road culverts and its allied structures & Road Crossing of Trenches shall be designed for Class 'AA' loading (wheeled and tracked both) and to be checked for Class 'A' loading as per IRC standards.

xi) **Railway Supporting Structures, Rail Culverts**

Railway supporting structures and rail culverts shall be designed as per Railway Bridge Rules.

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/sq.m or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, if any shall be designed to prevent transfer of such vibrations to the adjoining structures. For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

c) **Equipment Loads**

- i) Loadings (both static and dynamic) of major and minor equipment, including boiler, Turbine-Generator, BFP, PA, FD, ID, seal air fans, Coal Mill, Feed water heater, De-aerator etc. obtained from the manufacturer's certified drawings of the specified equipment to be furnished.
- ii) All equipment, tank and piping design loadings shall include Hydraulic Testing loads.
- iii) Air and gas duct loadings shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.
- iv) Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads.

Unless otherwise specified, the vertical and horizontal loadings

- shall conform to the applicable sections of the IS specifications.
- v) Weight of equipment, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.
 - vi) All structural components shall be designed to accommodate anticipated concentrated loads which shall or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

- vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.
- vii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

d) Wind Loading

Wind loading shall be in accordance with Indian Standard Code IS:875 (Part 3) (Latest Revision) for a basic wind speed of 44 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k_1) shall be considered as 1.07 for all structures. The k_2 , k_3 , k_4 factors shall be considered as per IS: 875(part 3 latest revision).

e) Seismic Loading

The lateral forces shall be established in accordance with the recommendations of IS:1893 (Latest Version only). The site falls in Zone-III as identified in the map in IS:1893 and hence seismic forces would be considered accordingly for the structures and buildings. Importance factor shall be taken as 1.75.

Seismic Load shall be considered in all three directions for analysis and design of all the buildings & Structures even if it is not warranted as per

IS-1893.

For all the buildings & structures, Response Spectrum Method shall be used for the calculation of seismic forces. Material damping factor and number of modes to be considered for the analysis shall be as per recommendation in the code referred above. The number of modes to be considered in the analysis shall be such that at least 95% of the modal mass is excited.

f) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose shall be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Mean Daily minimum ambient temperature during coldest month of the year = 7.6°C

Mean Daily maximum ambient temperature during hottest month of the year = 47.5°C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/sq.m for the areas at different levels through which steam piping is routed. However, the loading shall be checked as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

h) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

However, for the design of sub-structure of pump house and underground liquid storage tanks earth pressure at rest shall be considered with coefficient of earth pressure at rest shall not be less than 0.50.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all

underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load for all underground structures and foundations shall be considered as 2.0t/sq.m in general unless mentioned otherwise.

i) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter. For frame analysis, the lateral crane surge shall be applied on one side of the frame at a time and in either direction.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875/IS:807 (Latest Revision). The minimum impact factor to be used in design shall be as follows:

Crane loads

- a) For vertical force, an impact factor of 25% of the maximum crane wheel load for crane girder 10% for column and foundation.
- b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail.
- c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

- a) Impact factor of 10% of lifted load of hoist for monorail and support design.
- b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

j) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing as far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

k) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House Columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads. However, after finalization of all the Pipe/Cable racks adjacent to first row of Boiler columns, the Main power house shall be analyzed and designed again for the actual loads. If warranted, any design changes shall be incorporated by the contractor during the course of the engineering without any cost implication to the Owner.

All Power House Columns along the transformer yard, shall be designed for an additional load of 50KN/m for horizontal pipe / cable rack in addition to conductor pull load from substation. However, after finalization of all the Pipe/Cable racks the transformer yard, the Main power house shall be analyzed and designed again for the actual loads. If warranted, any design changes shall be incorporated by the contractor during the course of the engineering without any cost implication to the Owner.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

l) Thrust Load

Thrust blocks shall be designed against the thrust load from pipe lines considering the test pressure in the pipe lines and as per the relevant IS Code with adequate factor of safety.

3.01.00 Stability of Structures

Design shall be checked against buoyancy due to the ground water (Ground water table shall be considered at Plant Finished Grade Level) during construction and maintenance stages for structures like underground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading and surcharge. For purpose of calculating downward load due to any overburden, only the mass located vertically above the

projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

- a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
- b) Factor of safety against sliding shall be 1.5 minimum.
- c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

3.02.00

Load Combinations

Buildings and structures shall be designed to resist the load stated in the previous section acting in the following combinations.

While designing consideration shall be given to the following load combinations:

- i) $DL + LL$
- ii) $DL + LL + PL + Equip \pm TL$
- iii) $DL + LL + PL + Equip + Cb + CtLA \pm CS \pm TL$
- iv) $DL + LL + PL + Equip + Cb + CtLB \pm CS \pm TL$
- v) $0.9DL \pm EL \text{ (for DL only)} \pm TL$
- vi) $0.9DL \pm WL1 \pm TL$
- vii) $0.9DL \pm WL2 \pm TL$
- viii) $DL + *LL + PL + Equip + Cb + Ct \pm EL \pm TL$

(* Appropriate portion of LL which is considered for working out EL shall

- only be taken)
- ix) $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1 + WL1) \pm TL$
- x) $DL + LL + PL + Equip + Cb + CtL1 \pm (CS1 + WL2) \pm TL$

Where the above loads are:

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe Load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for the combinations as stated above to assess worst effect on whole structure as well as its components.

Seismic Load shall be considered in all three directions for analysis and design of all buildings & Structures even if it is not warranted as per IS-1893.

The above mentioned load combinations are for general guidance. However,

applicable load factors & load combinations (for both serviceability & strength) shall be as per IS:875 (Part 5), IS-456, IS-13920 & IS-1893 all parts (Latest Revisions).

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses shall be permitted.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under-ground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab & intermediate piers of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water (Ground water table shall be considered at Plant Finished Grade Level) during construction and operation stage. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading and surcharge. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

3.03.00

Design Concepts

Wind and seismic forces shall not be considered to act simultaneously.

For the design of main plant structures during seismic condition, the tank shall be considered full up to operating level. For other load combinations, tank in flooded condition shall be considered.

`Lifted Load' of crane shall not be considered during seismic condition.

For analysis & design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level.

If R.C.C. floors and roofs except those cast over metal decking are assumed to

act as diaphragm transmitting lateral loads to braced bays then main beams/girders shall be provided with shear connectors. However, whenever large/more number of cutouts is provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening /chequered plate / grating on other side.

For R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns.

Roof decking sheets shall be designed as per IS:801 to carry the self-load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per BS:5950. Suitable shear studs shall be provided as per BS:5950 on the top of roof beam.

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE (Poly tetra Fluoroethylene) bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Ultrasonic pulse velocity tests shall be carried out for the top decks of all machine foundations viz. FD Fan, Mill foundations, TG deck along with substructure, Boiler Feed Pump foundations, etc., to ascertain the homogeneity & integrity of concrete.

Whenever any structure under this contract shall carry or receive additional load from the work of any other contract, the structures under this contract shall be provided with sufficient margin to carry the above load, details of which shall be finalized during detail engineering.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.00.00

DESIGN OF REINFORCED CONCRETE STRUCTURES

- a) Reinforced Concrete Structures shall be designed in accordance with the requirements of IS-456 (Latest Revision), IS-13920, IS-1893 (Latest revision)& IS-875 (Latest Revision) or as specified in this specification for all possible combination of loads, e.g. dead load, live load, crane loads, wind or seismic loads, soil loads and surcharge loads etc. Ductile Detailing as per IS-13920 and IS:4326 shall be adopted. Curtailment in reinforcement shall not be allowed for RCC slabs.

The following grades of concrete as per IS-456 shall generally be used.

Sl. No.	Class	Grade of conc.	Min. cement content Kg/cum	Max. free water cement ratio
1.	i) Plain cement concrete used for screeds and fill between two foundations one above other at different levels	M15	240	0.6
	ii) Lean concrete below all foundations, plinth beams, drains, pits, etc.	M10	-	-
2.	i) Plinth protection.	M20	300	0.55
	ii) Grade slab, RCC drains and trenches, Paving, RCC Manholes and Chambers	M30	330	0.55
	iii) Precast cover slab	M25	-330	-45
3.	i) Reinforced concrete for super structure and foundation	M30	330	0.45
	ii) Reinforced concrete for water retaining structure	M30	330	0.45
	iii) RCC roads (Main road & approach road)	M30	330	0.5
4.	Pre-cast concrete	M30	300	0.5
5.	Reinforced concrete for deck & substructure of all heavy & vibrating equipment such as TG foundation, TG Top Deck, Crusher, ID, FD fan, STG, BFP, Mill & Fan Foundations, Cooling tower basin	M35	340	0.45
6.	TG Top Deck	M35	340	0.45
7.	Piles	M30	400	0.5
8.	For Chimney refer the respective section.			

- b) Reinforcing bars shall be TMT CRS (corrosion resistant steel) bars of minimum grade Fe 500 conforming to IS-1786 (Latest Revision) and Mild Steel bars conforming to IS: 432 (Grade I)(Latest Revision) of vendor approved by Owner/consultant. Fe 500D / Fe 550 or higher grade reinforcement bars may be used for construction but for design of primary reinforcement, the grade shall be restricted to Fe 500 only& for design of

secondary reinforcement (stirrups & ties), the grade shall be restricted to Fe 415 only. Test certificate for reinforcement steel shall be obtained from recognized agency, before using by the contractor. If the steel is purchased by the contractor, Engineer may desire to check the testing of the same & the contractor shall arrange it in approved laboratory at his own cost.

- c) Ordinary Portland cement namely Grade 43 conforming to IS: 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations. Higher grade 53 may be used in the work but the design restricted to Grade 43 only.
- d) The design of R.C.C- Structures shall be carried out by limit state or working stress method as per the provisions of IS-456 (Latest Revision). Working stress method using IS-456 shall be followed wherever mentioned in the specification. Otherwise limit state method shall be followed for all other structures.
- e) All Concrete tanks/liquid retaining structures/liquid conveying structures shall be designed in accordance with the recommendation of IS-3370 (Latest Revision) as un-cracked section.
- f) Grouting material:

Grouting shall be done with Conbextra GP-2 or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips. Grouting thickness shall be as per manufacturer's recommendation subject to a minimum of 25mm for equipment foundations Grouting thickness shall be 50mm minimum for all structural columns.
- g) For reinforcement detailing IS:5525(Latest Revision), IS: 13920 (latest revision) and SP:34 shall be followed.
- h) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.
- i) Liquid Retaining Structures

All RCC liquid retaining/conveying structures shall be leak proof and designed as un-cracked section in accordance with IS:3370 (Latest Revision).

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement.

All underground structures and water retaining structure etc. shall be provided with integral water proofing admixture and non-shrink polymeric water proof grouting compound by injection from inside/outside along with application of two coats of acrylic polymer modified cementitious

compound for water proofing coating as per approved manufacturer's specifications on outside surface.

Internal surface of all water retaining structures shall have 20 mm thick plaster (1:3) admixture with approved quality water proofing compound. 10 mm thick plaster (1:3) to be provided below roof slab of water retaining structure.

Foundations below ground level coming on direct contact with soil shall be treated with two (2) coats of hot bitumen (85/25) over a coat of primer except for foundations requiring water proofing / hydro-insulation for ingress of sub-soil water.

Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

5.00.00 FOUNDATION DESIGN

The design of foundation open / pile shall be carried out by Limit State or working stress method as per the provisions of IS-456(latest revision).

The foundation shall be placed on firm and incompressible virgin strata with adequate bearing capacity. For open foundation depth of footing shall be not less than 1.0m below virgin soil. However, Open foundations in filled-up soil may also be considered for the foundations of very small structures having net SBC requirement of 5 T/sq.m and below at the discretion of Owner / consultant with the minimum depth of foundation as 1.5M from FGL& with a permissible total settlement of 25mm. The contractor shall carry out confirmatory SBC report and submit for approval before submitting design and drawings in filled up soil. However maximum SBC allowed in filled up soil is 5T/m² only.

For analysis & design of all foundations, ground water table shall be considered at the Finished Ground Level.

Foundation shall be checked for safety against overturning, sliding and uplift considering ground water table at the Finished Ground Level. Loss of contact for foundations is not permitted.

Crushers for both Coal and Limestone shall be on VIS

RCC deck of any vibrating equipment may be supported on vibration isolation system consisting of steel helical spring units and viscous dampers which in turn will be supported on RCC foundation system.

ID, PA & FD fans are to be provided as per manufacturer's proven practice.

The concrete foundation for supporting the turbine generator will be completely isolated from the building floors for vibration control. The foundation for Turbo-generator shall rest on suitable vibration isolation system consisting of springs and visco dampers (supplied by owner approved vendor).

The foundation for Boiler Feed Pumps / motors shall rest either on suitable vibration isolation system consisting of springs or on solid concrete foundation if the pumps / motors are placed on ground floor. In case, the Boiler Feed Pumps / motors are erected on elevated floor (above ground floor), foundations shall rest only on suitable vibration isolation system consisting of springs.

For booster fans, the supports shall be on VIS.

Pile foundation, if adopted, shall be designed in accordance with IS:2911(Part-I / Sec-I, II and III) (Latest Revision).

The type, size, depth of the foundation / pile shall be based on the approved soil investigation report of Contractor/Owner's soil investigation report whichever is conservative

5.01.00 Foundations

Top of RCC columns/ pedestals for the steel columns (Boiler, PowerHouse Columns, Bunker columns, ESP columns, etc.) shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns shall have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Common foundation should be provided for columns both side of the expansion joint and shall be designed for loading on both columns.

Foundations for Buildings and structures shall be designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for those structures. The foundation sections shall be sized and reinforced adequately for moments and shear stresses.

5.02.00 Heavy and rotating Equipment Foundations

Loadings (both static and dynamic) of major equipment such as Turbine Generator, Boiler feed pump, Mill, FD & ID fans, Crusher, etc. shall be obtained from the manufacturer's certified drawings of the specified equipment. RCC decks of FD, ID, PA fan, Turbine Generator, Boiler Feed Pump / motors & Crushers, shall be supported on vibration isolation system consisting of steel helical spring units and viscous dampers shall be completely isolated from the building floors which in turn will be supported on RCC foundation system. The foundations for Turbine Generator to rest on suitable vibration isolation system consisting of springs and damper.

The concrete foundation for supporting the turbine generator will be completely isolated from the building floors for vibration control. The foundation for Turbo-generator shall rest on suitable vibration isolation system consisting of springs and visco dampers (supplied by owner approved vendor).

The foundation for Boiler Feed Pumps / motors shall rest on vibration isolation system consisting of springs.

For static and dynamic analysis of machine foundation following data shall be furnished by the equipment manufacturer.

- a) Loading diagram showing static and dynamic loads and points of application of loads.
- b) Operating speed of m/c; Critical speed of m/c.
- c) Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.
- d) Location of C.G. of machines in all three axes.
- e) Mass Moment of Inertia.
- f) Allowable amplitude/velocity of vibration at machine bearing points.
- g) Temperatures in various areas during operation.

Design of foundations for major equipment shall be done in accordance with relevant parts of IS-2974 (Latest Revision). Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.

- i) Foundations shall be isolated from adjacent structures for vibration control and it shall be designed to meet the manufacturer's deflection criteria and other manufacturer's recommendations.
- ii) The turbine generator pedestals shall be designed to meet the manufacturer's deflection criteria and other recommendations.
- ii) Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. However, frequency separation criteria and amplitude criteria as laid down in IS:2974(Latest Revision) and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied. A fatigue factor of 2.0 shall be considered for dynamic forces / due to normal unbalance. For design of foundation of large fans, heavy & rotating fan foundations etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

All block foundations resting on soil shall be designed using the elastic half space theory or Barkan's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with

tolerance not more than 5%.

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.

Wherever RCC top deck is designed with VIS for machine foundations, the design of the RCC top deck shall be designed and vetted by the reputed VIS manufacturer like GERB. However the overall responsibility of the overall structure including foundation lies with the EPC contractor.

Analysis and design of the Steam Turbine-Generator (STG) foundation, FD & ID fans, Boiler Feed Pumps & Crushers foundations shall be carried out in accordance with relevant codes IS: 2974 Part-3 (Latest Revision) and IS: 456 (Latest Revision) and/or manufacturer's requirements. The loads to be considered for static analysis and design shall consist of dead weight of the machine and foundation, machine power torque, condenser loads under normal operating condition, Equivalent static load due to machine unbalance, thermal elongation forces, forces due to one sided operation of the condenser, forces due to condensate pump failure, vacuum loads, forces due to piping, frictional forces at machine sole plate level for turbine, generator and condenser, temperature distribution under operating condition, failure loads of turbine (blade unbalance/loss of blade/bowed rotor), failure loads of generator (short circuit loads), seismic loads due to generator, turbine and condenser and erection loads.

In case of machines supported on VIS with springs and viscous dampers it shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096.

For all equipment foundations supported on VIS system, the stiffness of the supporting substructure shall be at least ten (10) times that of spring elements as per DIN 4024.

While performing dynamic analysis of fan, TG & BFP foundation, effect of soil contributing to dynamic properties shall be considered.

Wherever VIS is provided for equipment inside the Power Plant – The Civil Design document / drawings for the RCC Top deck above the VIS supporting the equipment shall be vetted / designed by the VIS spring manufacturer and the same shall be submitted to NLC / Consultant by the contractor for approval during detailed engineering. However the overall responsibility for the structural safety, rigidity & soundness of the entire structure lies with the contractor.

5.03.00 Open Foundations

In case open foundations are adopted, the following shall be adhered to:

- a) Minimum width of foundation shall be 1.0 m.
- b) Minimum depth of foundation shall be 1.0 m below NGL.
- c) It shall be ensured that all foundations of a particular structure/buildings/facility shall rest on one bearing stratum, i.e. either overburden or rock.
- d) Wherever the intended bearing structure is weathered rock but the actual stratum encountered during foundation excavation consists of both overburden soil and weathered rock at founding level, under such cases either the foundation shall be lowered completely into the weathered rock or the overburden soil upto the weathered rock level shall be removed and built up through PCC up to designed foundation level.
- e) The net allowable bearing pressure values to be adopted for design upon Owner's approval shall correspond to total permissible settlement as mentioned under para "permissible settlement of foundations" or the permissible settlement from functional requirement, whichever is more stringent.

Permissible settlement of foundations:

Maximum allowable total settlement for all foundations of any structure/facility should be restricted to 25 mm except as listed below.

For all non-plant buildings as mentioned in the following list, Maximum allowable total settlement should be restricted to 40 mm for all foundations.

- Canteen
- Fire Station
- Weigh-bridge
- Time office and Security Complex including Gate-I
- Watch Tower
- Workshop
- First Aid Centre
- Permanent Stores
- Construction Store
- Hydrogen and Carbon-di-oxide Cylinder Storage Building

- Cycle/ Scooter/car stand at the main gate

5.04.00 Pile Foundations

In case piles are adopted, following shall be adhered to:

- The pile foundation shall be of RCC, Cast-in-situ bored, precast/cast-in-situ driven pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.
- The minimum diameter of pile shall be 450mm for cast-in-situ and 300mm for precast piles. The uplift and lateral load capacity shall be established by field test.
- Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.
- The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter like (SPT & SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc.) for Owner's approval.
- The piling work shall be carried out in accordance with IS: 2911 (Relevant part) (Latest Revision) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Owner's approval.
- Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical	}	Minimum of 2 Nos. in each mode.
Lateral		
Uplift		

For large size projects (for piles more than 1 000 numbers), a minimum of two tests for first 1 000 piles and additional one test for every additional 1 000 piles and part thereof

The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per IS: 2911 (relevant part) (Latest Revision).

- Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

- Vertical -2.0 % of the total number of piles provided.
- Lateral -2.0 % of the total number of piles provided.

The routine tests on piles shall be conducted up to test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4) (Latest Revision).

In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Owner.

- h) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4) (Latest Revision). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.
- i) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

5.05.00

Other Requirements

- i) In case of high ground water table, for excavations comprehensive dewatering arrangement shall be required. Scheme for dewatering and design with all computations and back-up data of dewatering and sheet piling shall be submitted for Owner's information.
- ii) The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches/channels.
- iii) Excavation for open foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC of Grade M 10. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.
- iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils. Where ever necessary Sand filling shall be used for back filling.
- v) Excess/surplus excavated material (debris and other unusable materials as decided by owner) shall be disposed of by the Contractor as per the instructions of the Owner upto a lead of about 5 km spread in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to

75% of relative density for non-cohesive soils.

- vi) CBR tests for rigid / concrete pavement design shall be carried out by Contractor after earth filling has been completed, if applicable.
- vii) The storage tanks shall rest on flexible tank pad resting on an open foundation / pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency approved by owner/consultant having wide experience in execution of similar works. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Owner. In addition to the above, in case of an open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which shall establish complete bearing with the foundation fill.

6.00.00 GENERAL REQUIREMENTS

6.01.00 Minimum Thickness of Structural Elements

The following minimum thickness shall be followed:

Pile caps	1.5 times the dia of pile
Suspended floor / slab / walkways / canopy slabs, etc. (Thickness of roof slab and intermediate floors shall be measured excluding trough depth of metal deck sheet)	150 mm
Ground floor slab/Grade slab (non-suspended)	150mm or as per design requirements whichever is higher
Water Retaining slabs / walls	200 mm
Walls of Cable / pipe trenches / underground pits / Launder walls and base slab	150 mm
Drain walls and base slab upto 500mm depth	125mm
Drain walls and base slab more than 500mm depth	150 mm
All footings (including raft foundations)	300 mm

Parapets	125 mm
Sunshades at edge	75 mm
Pre-cast louvers / fins	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	100 mm
Paving (except for RCC Roads)	150mm or as per design requirements whichever is higher
Basement walls and base slab	250 mm
Silo / bin walls	200 mm
Underground reservoir	
Below ground (Walls and base)	250 mm
Above ground (Walls)	200mm
RCC Roads	250mm

The above are minimum requirement only unless otherwise mentioned elsewhere in the specification.

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per Fig 1 or Table 16a of IS 456 (Latest Revision) or specified above, whichever is higher.

6.02.00 Minimum Heights for Pedestals/Encasements of Steel Columns

Pedestals to Steel Columns for building structures:

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following unless otherwise specified.

- a) Open area : 300 mm above paved level
- b) Covered area : 300 mm above FFL

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

Pedestals to Steel Columns for Equipment structure:

- a) Equipment in open area : as required (300mm min)
- b) Equipment in covered area : as required (150 mm min)

- c) Structures and equipment : as per vendor's data
supplied by vendor subject to minimum as
specified above

6.03.00 Ground floor slab-on-grade

Ground floor slab-on-grade shall be minimum M-30 grade RCC construction laid over minimum 100mm thick lean concrete of Grade M10. Minimum consolidated 230mm thick graded BG stone or laterite (63mm down size) soling with interstices filled with sand/gravel and compacted mechanically, shall be provided as sub-base below lean concrete. The sub-base shall be laid over rammed and compacted minimum 300 mm thick (Min. 90% Proctor density) sub-grade.

The ground floor slab shall be of minimum 150mm thick or as per design requirement (whichever is higher) with double layer reinforcement (top & bottom) of 10mm (minimum) dia at the rate of 200 (maximum) c/c both ways with 50 mm thk IPS floor finish.

For Toilet Floor shall be 100 thick PCC (M25) with 50 thick floor finish as per system requirement .

6.04.00 Stairs, Platforms, Handrails

All internal stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 8mm thick chequered plate construction. All outdoor stairs, platforms and walkways shall either be of RCC or Structural Steel with GI grating made of minimum 40 x 6 mm Flats. S.S handrails shall be provided for TG building and service building

All handrails (For steel structures and RCC structures) made of MS Galvanized hand railings with 40 mm NB (medium) main posts and 40 mm NB (medium) as horizontal rails as per IS:1161(Latest Revision) with GI toe guard min 6 mm thick & min 150 mm wide shall be provided including throughout staircase and landing.

7.00.00 ROADS

Geometric design of road shall be done in accordance with Indian Road Congress Standard. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test, shall be carried out as per the procedure outlined in IS-2720 (Part-XVI)(Latest Revision). CBR test shall be carried out in remoulded soil samples under soaked condition.

All roads shall have hard shoulder on either side of carriageway. Shoulders shall have sufficient load bearing capacity to support loaded trucks. A flatter

slope of 1 in 30 shall be provided on shoulders.

Only RCC box culverts shall be provided for drainage and for all the underground conduits at road crossings. Level crossings shall be provided where a Railway siding line crosses the road. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

At all road crossings RCC box culverts along with manholes (if required) on both sides shall be used. Such road culverts and its allied structures including R.C.C. Road Crossing of Trenches shall be designed for Class 'AA' loading (wheeled and tracked both) and to be checked for Class 'A' loading as per IRC standards.

For RCC roads the cross section as per Clause No 2.07.00/Vol II-G2/Part A/Section X shall be followed.

8.00.00 DRAINAGE

Open RCC rectangular drains shall be provided for storm water. However, perforated RCC cover slabs (minimum 50mm thick or as per design, whichever is higher) with GI gratings at 4m interval shall be provided for drains in Boiler, Transformer and Switch yard areas. The thickness of sides & bottom of drains shall be minimum 125 mm or as per design considerations whichever is higher. Drains shall have minimum 600mm base width. RCC box culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads. For depth more than 500mm drain, minimum 150mm wall thickness with double layer reinforcement shall be provided.

Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec.

9.00.00 TRANSFORMER TRACK & JACKING PAD

Lay out of transformer track and jacking pads shall be as shown in appropriate drawing.

Transformer track shall be designed as beam on elastic foundation. For this, appropriate soil investigation / test shall be carried out to establish design parameters. Grade of concrete, reinforcement etc. shall be as specified earlier.

10.00.00 MISCELLANEOUS DESIGN / CONSTRUCTION CRITERIA

- 1) All RCC/Steel buildings shall be provided with RCC Plinth beams connected to RCC Columns/Pedestals. All masonry walls from ground floor shall be placed on reinforced concrete plinth beams connected to RCC Columns/Pedestals. However, light internal partitions may be placed

on ground floor slab. The plinth beam shall be partially above FGL and partially below FGL. Minimum embedment of the plinth beam below Finished Ground level (FGL) shall be 300 mm. All RCC/Steel buildings shall be provided with Wall/Tie beams at every 2.5 metre height of brick wall.

- 2) The steel column base plate along with stiffening gusset plates shall not be protruded above floor level for main plant area. The column base assemblies shall be encased with concrete M20 upto floor level.
- 3) For exposed areas the columns shall have a minimum encasing of 300 mm above paved level in main plant area.
- 4) Ramps for building entrance shall be cast in situ RCC slab and the slope of ramps shall not be more than 1 (vertical) to 8(horizontal).
- 5) Minimum 100 mm thick lean concrete M10 shall be provided below all underground structure, trenches etc., to provide a base for construction.
- 6) All buildings shall have RCC/steel framed super structure. All walls shall be non-load bearing infilled panel walls.
- 7) Duct banks consisting of PVC/GI conduits for cables shall be provided with reinforced concrete encasing of M25grade. The minimum depth of top of duct bank from grade level shall be 500mm.
- 8) Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches, manholes supporting covers, supporting edges of pre-cast covers. RCC stairs/ steps and any other places where breakage of corners of concrete is expected.
- 9) Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. Trenches and drains shall not be clubbed together by providing a common wall. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M-25grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. The minimum drainage slope along line shall be 1 in 1000.
- 10) All underground concrete structure such as basement, sumps water-retaining structure shall be designed for water tightness.
- 11) The concrete surface of foundations in contact with earth shall be provided with two coats of hot bituminous painting (85/25) conforming to IS:702 @ 1.2kg/sq.m in each coat) over a coat of bitumen primer except where special water proofing is specified for specific structures mentioned elsewhere.

- 12) All joints, including construction and expansion joints for the water retaining structure and others below subsoil water level shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230mm.
- 13) All mild steel parts used in the water retaining structures shall have anticorrosive epoxy based paint or equivalent.
- 14) Anti-termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, switchyard area etc., as per IS-6313 (Latest Revision) and other relevant standards.
- 15) Concrete hume pipes for underground service(sewage line) shall of class NP3 as per IS-458 (Latest Revision).
- 16) For all buildings suitable arrangements for draining out of water collected from equipment, blowdowns, leakages, floor washing, fire-fighting etc., shall be provided for each floor.
- 17) All RCC walls and slabs shall have two layers of reinforcement for section having thickness 150 mm and above.
- 18) All gratings shall be made of 40x6 thick GI flat unless noted elsewhere in the specification. Stairs treads made of grating shall be provided with non-skid abrasive nosing.
- 19) NOT USED.
- 20) Unless stated elsewhere specifically in this specification, the finished floor level of any building shall be at least 500 MM above the finished grade level and 800mm above FGL for electrical buildings. The finished paving level shall be at least 300mm above FGL for Boiler Area and switchyard area.
- 21) For RCC buildings of more than 15M shorter span steel roof truss/girders maybe provided to support the concrete roof on permanently colour coated (on exposed face) galvanized M.S. troughed metal decking over concrete columns. Gable and side cladding will be constructed with fly ash brick masonry.
- 22) Sealing of joints shall be done by two part polysulphide sealant and shall be from approved manufacturer conforming to IS: 12118 (Latest Revision). Material shall consist of polysulphide polymer and a curing agent. Clear cover to reinforcement shall be as per IS:456 for moderate exposure condition. However, for concrete in contact with soil and water it shall not be less than 50 mm.
- 23) Generally foundation for buildings & equipment shall not be structurally connected to ground floor slab.



- 24) Allowable differential settlement between two foundations shall be as per IS:1904 (latest). Foundations for structures and equipment shall be proportioned to resist the worst conditions of loadings and shall be generally designed as per the provisions of IS:1904.
- 25) For equipment foundations, the total and differential settlements that are likely to occur shall be assessed. Design of such foundations will restrict expected settlements to within limits required for proper operation of the plant.
- 26) Machine foundations shall be separated from adjacent building column foundations by a minimum gap of 25 mm to avoid propagation of vibrations into the buildings.
- 27) For all settlement sensitive equipment and structures, due care shall be taken during designing of structures and foundations to limit the settlement as required for efficient functioning.
- 28) In general, for fixing of gates/screens with the RCC wall/slab, anchor fasteners or any other anchors shall not be used. The fixing shall be done with cast-in situ bolts/pockets/inserts in RCC.
- 29) If any similar design criteria mentioned elsewhere in this specification contradict the above, the stringent of the criteria shall be adopted for design.

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VIBRATION ISOLATION SPRING FOUNDATIONS

1.0 General Requirement

Steel helical springs and viscous dampers shall be provided for equipment requiring foundations with vibration isolation system by the supplier with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 800 MW.

Complete Vibration Isolation System with Steel Helical Springs and Viscous Dampers shall be provided for the foundations of Crushers.

Complete Vibration Isolation System with Steel Helical Springs and Viscous Dampers shall be provided for the foundations of Turbo-generator. For Boiler Feed Pump and any other vibrating/rotating equipment resting on intermediate floors, springs to be provided if recommended.

2.0 Material (Design & Supply)

2.1 Steel helical springs and viscous dampers shall consist of

- i) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.
- ii) Frames for pre-stressing of spring elements.
- iii) Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks and hand operated pumps shall also be provided.
- iv) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs.

2.2. The objective of designing the supporting arrangement for any rotating equipment shall be so that the vibration level is maintained as minimum as possible under all operating conditions. Accordingly, respective rotating equipment shall be supported on RCC deck slab which in turn shall rest on vibration isolation unit consisting of steel helical springs and viscous dampers, which in turn shall be supported on RCC supporting structure. The above design shall form part of this specification.

2.3. The spring units shall have definite stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 30% of vertical stiffness. The stiffness shall be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 to 5 Hz.

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- 2.4. The damper units or spring-cum-damper units shall be of viscous type offering velocity proportional damping. The damper units shall be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units shall be such that the designed damping is provided using reasonable number of units. Damper shall have damping resistance ranging from 40 kN sec/m to 750 kN sec/m.
- 2.5. The sizes of the spring units, damper units and spring-cum-damper units shall be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.
- 2.6. The steel helical springs and viscous dampers shall be designed for ensuring "fit and forget" guarantee.
- 3.0. Manufacturing & Testing
- 3.1. Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub-vendor/supplier. For this purpose, the contractor/sub vendor shall submit the detail program for approval of engineer and take up the manufacturing/testing after approval of such program. The program shall include:
- i) Manufacturing schedule and quality check exercised during manufacturing.
 - ii) Detail of test to be carried out at the manufacturing shop with their schedule.
 - iii) Special requirements, if any, regarding concreting of top deck.
 - iv) Complete step-by-step procedure covering the installation and commissioning of the spring system.
 - v) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.
 - vi) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.
 - vii) Checklist for equipment required at each stage of erection.
 - viii) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.
 - ix) Bill of materials (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.

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- x) Any other details which may be necessary to facilitate design and construction of the foundations/structures.
- 3.2 The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedures shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.
- 4.0 Erection, Commissioning and Supervision
- 4.1 Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre stress in spring elements, making final adjustments and alignments etc. all shall be done a specialist supervisor of supplier/sub vendor trained for this purpose.
- 4.2 The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.
- 4.3. The contractor shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".
- 5.0. Realignment of Spring System
- If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of Commercial Operation of the machine, the same shall be done by the contractor as and when asked for at no extra cost of the Owner.
- 6.0. Acceptance Criteria
- Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed:
- i) General workmanship is being good and as recommended by the manufacturer is approved by the Engineer.
 - ii) Tolerances are within the specified limit
 - iii) Material test certificate (MTC) is in compliance with the applicable codes/standards.
 - iv) Bought out material is from the approved manufacturer/vendor
 - v) Bought out material is matching with the approved sample

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7.0. Codes and Standards

Latest revision of following codes shall be used for the design of the spring supported foundations :

IS: 456	Code of practice for plain and reinforced concrete.
IS: 2974	Code of practice for design and construction of machine foundations.
IS: 1893	Criteria for earthquake resistant design of structures
DIN: 4024	Machine foundations; Flexible supporting structures for machine with rotating masses
DIN: 2089	Helical compression springs out of round wire and rod : calculation & design
DIN: 2096	Helical compression springs out of round wire and rod : quality requirements for hot formed compression springs.
VDI: 2056	Criteria for assessing mechanical vibrations of machine.
VDI: 2060	Criteria for assessing the state of balance of rotating rigid bodies.

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Special Conditions for Construction of TG Foundation

1.0 Scope

- i) The work to be performed under this contract consists of providing all materials except those supplied by the Purchaser, shuttering, staging, inserts, construction equipment, labour and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of the work, all in the strict accordance with the drawings, schedules and specifications and including revisions and amendments thereto and such detailed drawings as may be provided by the Consultant, during the execution of the work.
- ii) It is not the intent to specify completely herein all the details of designs and construction of the structure. However, the structure shall conform in all respects to high standards of Engineering, design and workmanship and be capable of performing in continuous commercial operation upto contractors guarantee in the manner acceptable to the Purchaser / Consultant who will interpret the meaning of drawings and specifications and shall have the power to reject any work or materials which in his judgment are not in full accordance therewith.

2.0 Form Work

- i) All forms shall be abundantly wetted on both sides before concrete is poured. The date of removing forms for each individual stage of construction shall be fixed by the Purchaser / Consultant.
- ii) The minimum period for striking of formwork shall be as follows:-
 - a) Vertical sides of beams and pedestals - 7 days
 - b) Bottom of beams / slabs - 28 days

However, the vertical faces shall be loosened after 24 hours of completion of concreting the supports.

- iii) Concrete surface shall not normally be patched or otherwise treated after the removal of forms. Where the surfaces exposed on stripping is not of a satisfactory nature, owing to the contractors failure to take necessary precaution before, during or after the concrete placing, such surfaces shall be worked and finished in accordance with the instructions of the Purchaser / Consultant at the cost of the contractor. The pores shall be filled in with a neat solution of cement and water applied by brush and when dry the surface shall be rubbed down with carborundum stone. The cost of the above treatment shall be deemed to be included in the unit rate entered by Contractor. The top surface of the T.G. deck shall be float-finished, unless otherwise specified to the required levels. There must be no surface grouting or treating which might draw the 'fines' to the top. All shuttered surfaces shall be left as they strip without removing boards or panel markings. Any

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serious honey combing will render the concrete work liable to rejection and cutting out and re-concreting wholly or partly as the Engineer in Charge directs. All costs involved in repairing defect shall be borne by the Contractor.

- iv) The arrangement and method for movement of workers during TG construction to various levels of the TG foundations shall be submitted well in the advance to the Engineer- in – Charge for his approval for taking up the work.
- v) In addition to the above paras the contractor shall also satisfy all other requirements for formwork.

3.0

Staging

- i) The entire staging for supporting the formwork, walkways and platforms for placing concreting equipment such as vibrators, etc., shall be of structural steel. The staging shall be designed for the worst combination of loading as specified hereinafter. The Staging system for TG deck shall meet the following minimum requirements Or Contractor's proven practice subjected to approval of owner/consultant.
 - a) All vertical posts & horizontal ties shall be of minimum 40 NB MS Pipe (Heavy duty).
 - b) The vertical posts spacing shall not be greater than 600mm in both the directions.
 - c) Horizontal ties spacing shall also be not greater than 1000mm in both the directions.
 - d) Sufficient cross bracings as per design requirement shall be considered in both directions for stability suitably.
- ii) The Contractor shall submit 6 copies of design calculations and staging drawing to prove adequacy of the staging for approval of the consultant. On receipt of final approval, the contractor shall supply 20 copies of approved drawings for distribution.
- iii) The staging shall be so designed that no load from platforms are passed on to the formwork at the top.
- iv) All platforms, walkways etc., shall be clear of the formwork and at least 200mm above it. The width of platforms and walkways shall be at least 1.2 metres for easy movement of labour both ways.
- v) The platforms shall be planks or bamboo mats (clamped with steel strips suitably stiffened to avoid springing).
- vi) The form work and staging shall be designed for a live load of 1000

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Kg/m².

- vii) Unit weight of green concrete shall be considered as 2500kg/m³ for design of form work and staging.
- viii) The staging shall be braced in both the directions.
- ix) The staging shall be supported on rigid surfaces at ground level.
- x) The staging shall be sufficiently rigid to prevent any distortion in the form work.

4.0 Special Precautions

- i) The contractor shall take all precautions to ensure concreting of TG Raft, columns and TG Deck in one pour each. Concreting shall be continuous and no break in concreting shall be permitted.
- ii) The Contractor shall prepare a scheme for concreting giving details of number of mixers, labour, vibrators, pouring schedule and obtain prior approval of the same from the Engineer-in-Charge before starting of concreting.
- iii) The Contractor shall ensure that at no time the temperature of the green concrete exceeds 38 degree C by taking proper precautions. If required, ice shall be added to control the temperature at no additional cost to the Purchaser.
- iv) Approved "Retarders" shall be used by the contractor in the proportions specified by the manufacturer for total concreting work of the TG foundation. The cost of the admixture shall be included in unit rates quoted by the Contractors.

5.0 Test for Soundness of Concrete

- i) After completion of the construction of TG foundations, the contractor shall get the Deck and column tested for soundness of concrete by "ultrasonic wave – non – destructive test method" from reputed research institution like IIT /SERC etc. at no extra cost to the Purchaser.
- ii) If the test report calls for any rectification in the concrete works by way of pressure grouting or otherwise, the same shall be carried out by the contractor at no additional cost to the Purchaser to the satisfaction of the Purchaser / Consultant.
- iii) If require, any additional test to establish the adequacy of the rectification works carried out shall be done by the contractor at no extra cost to the Purchaser.



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha**

VOLUME: II-G/1
SECTION - III
SPECIFIC DESIGN REQUIREMENT
[STRUCTURAL]



Development Consultants Pvt. Ltd.

Vol. II-G1/Section-III
Specific Design Requirement [Struc.]



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VOLUME-II-G/1

SECTION-III

**SPECIFIC DESIGN REQUIREMENT
[STRUCTURAL]**

1.00.00 STRUCTURAL STEEL DESIGN

- a) Structural Steel design shall be as per IS: 800 – 2007. However, latest revision of National Building Code (NBC) shall also to be consulted for all general guidelines given with specific mention to relevant codes given in NBC.
- b) Lateral forces along the length of the building shall be resisted by bracings in horizontal and vertical frames. The transverse lateral load shall be resisted by stiff jointed frame action or by bracing. Additional bracing or moment connection shall be used to assure stability of the structures.
- c) Structural steel will conform to Grade E350 / E250 of quality (A/BR/B0), semi killed / killed as per IS: 2062 (latest) for rolled steel members or plates. All structural steel plates and sections shall be procured from any make approved by Owner.

For Crane Girder Steel will confirm to Grade E350 / E250 of quality C (Killed).

- d) Shop connections shall be all welded and field connections shall generally be bolted (mainly for boiler and Main Power House) unless specified otherwise. Field bolts, wherever provided, shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS: 1367 (Latest Revision) for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. shall be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS: 1363 (Latest Revision) unless specified otherwise.
- e) Welding shall be in accordance with the recommendations of IS: 816 - Code of Practice (Latest Revision) for use of metal arc welding for general construction in mild steel and IS: 9595 (Latest Revision) - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members shall be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns shall be full penetration.

All butt welds shall be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding shall be conforming to AWS/IS classification.

- f) Galvanizing of steel structures (wherever specified for switch yard structures, transformer yard structures, handrails, gratings, etc.) shall be done after all fabrication work is completed. Zinc coating over galvanized surface of structural members and threaded fasteners shall not be less than 610 gm/sqm and 375 gm/sq.m of surface area respectively. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS: 573 (Latest Revision). All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS: 2633 (Latest Revision). All galvanizing work shall be done at shop.
- g) For painting of structural steel members : shall be applied with primer paint shall be single coat of zinc ethyl silicate primer of 75micron thick and conform to IS-2074 (Latest Revision). The surface preparation shall be done in accordance with IS : 1477 (Part I & II) (Latest Revision) – Code of Practice for Finishing of Ferrous Metals in Buildings. Two coats of synthetic enamel paint conforming to IS:2932 (Latest Revision) of approved shade and quality and not less than 50 microns each coat shall also be applied above primer coat with applicable tie coat of minimum 25 microns. Total Dry film thickness of the finished paint shall not be less than 200 microns For structures fabricated in shop, one additional coat of primer shall be given at the shop of 75 micron thick.
- h) All welding electrodes shall be of Low Hydrogen type conforming to IS: 814 (Latest Revision). All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. Or any other equivalent manufacturer accepted by Owner at site.
- Alternatively, flux coated arc welding (FCAW) conforming to AWS-classification which is a modified procedure of MIG/CO₂ (solid wire) can be used.
- If submerged arc welding is used, the bare wire electrodes shall conform to AWS/IS classification.
- i) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63mm, it shall be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and shall be followed as per approved welding procedure.
- j) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows:

Steel

Ultrasonic Test: Plates above 25mm thick shall be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test: 5% of the total length, Dye penetration shall be carried out to the root run.

Butt weld:

Dye Penetration Test: 10% of the total length, Dye penetration shall be carried out to the root run after back gouging

Radiographic Test / UT(Ultrasonic Test):: Generally splicing should not be provided in tension flange of Bunker Girders and crane girders. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300mm length shall be spot radiographed. When radiograph is not possible ultrasonic test shall be carried out after grinding the surface.

Ultrasonic Test: 10% of all other Butt welds except crane girder and bunker girder shall be subject to spot radiographic test and the entire balance butt weld for ultrasonic test.

k) Connections

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section shall be as follows:

- Full shear capacity for box section.
- 80% of full shear capacity or actual shear (if indicated in Sellers drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.
- All welds will be continuous. The minimum size of fillet weld shall be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections shall be provided during erection:

Welded Connection

Connection of secondary beam to main beam
Connection of bracing to column
Connection of bracing to longitudinal tie beam
Connection of longitudinal tie beam to column
Connection of spandrel beam to column
Connection of other secondary structures

HSFG Connection (Grade 8.8 bolts)

Splicing of column/transverse frame beam/ longitudinal tie beam
Connection of frame beam to column
Connection of Crane Girder to column
Connection between crane girders
Other major connections

Bearing Type Connection (HT bolts Grade 8.8)

All removable type connections

M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc.

2.00.00 LOADS

Loads as defined under Clause 3.00.00 Section-II shall be applicable.

3.00.00 LOAD COMBINATIONS

While designing consideration shall be given to the following load combinations:

- i) DL + LL
- ii) DL + LL + PL + Equip \pm TL

- iii) $DL + LL + PL + Equip + Cb + CtLA \pm CS \pm TL$
- iv) $DL + LL + PL + Equip + Cb + CtLB \pm CS \pm TL$
- v) $0.9DL \pm EL$ (for DL only) $\pm TL$
- vi) $0.9DL \pm WL1 \pm TL$
- vii) $0.9DL \pm WL2 \pm TL$
- viii) $(DL + *LL + PL + Equip + Cb + Ct \pm EL \pm TL)$

(* Appropriate portion of LL which is considered for working out EL shall only be taken)

- ix) $[DL+LL+ PL + Equip + Cb + CtL1 \pm (CS1+WL1) \pm TL]$
- x) $[DL+LL+ PL + Equip + Cb + CtL1 \pm (CS1+WL2) \pm TL]$

Where the above loads are:

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Limit state method to be followed for design of steel structures as per latest version of IS: 800. Applicable load factors to be used for Design of Steel Structures by Limit State Method of strength & serviceability as per IS: 800 (Latest).

Appropriate impact factor shall be considered as per IS: 875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS: 875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.

4.00.00 PIPE AND CABLE RACK STRUCTURES

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, vertical and drag, drag forces from pipe lines as per mechanical input etc.). The structures shall be adequately rigid to carry the forces from the pipelines at anchor points without undue deflection so that the pipelines are really anchored at the anchor points. Bridges shall be provided to support pipelines of smaller diameters for which maximum permissible span are less than the distance between supporting trestles.

It is envisaged that pipe/cable rack under this Package shall have to accommodate some additional pipes and cables, which are not in the scope of the Contractor. The Contractor shall keep reasonable margin for accommodating such additional pipes/cables in the rack structure, details of which shall be furnished to him during the detailed engineering stage.

5.00.00 OTHER SPECIFIC REQUIREMENTS

All steel framed structures shall be either "rigid frame" or "simple space frames" or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings shall be designed as simple space frame structures.

The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However wherever large cut outs (area more than 1.0 sq.m) are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support in the form of shear connector and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level. However heavy vibrating/rotating equipments shall rest on VIS if provided in intermediate floors. Resonance in structures: Structures supporting vibratory/reciprocating equipments shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall not lie within the range as per codal stipulation.

Chequered plates shall conform to IS: 3502 (Latest Revision).

All indoor gratings shall be electro-forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm x 6mm for indoor installation and outdoor installation. The opening size shall not be more than 30mm x 100mm. All gratings shall be hot dip galvanized @ 610 gm/sq.m.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

Only box sections shall be used for structural wall beams (provided at every 2.5 m height of brick wall) wherever brick cladding is envisaged.

Crane Girders

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange shall not be permitted. Bearing edges of crane girders shall be machined. Crane stoppers shall be designed in accordance with IS: 875(part-5).

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

Crane girders shall generally be of simply supported design, unless continuous crane girders are specifically required.

Each flange of crane girder shall have uniform thickness throughout its length. However width of flanges can be varied as per design requirement.

End bearing stiffener plates of crane girder shall be capable of transmitting the maximum reactions to the columns. The bearing surface of the bearing plate shall be planed/ machined to ensure full contact. Thickness of End Bearing stiffeners shall not be less than top flange thickness and their width shall not be less than width of bottom flange.

Tension flange of crane girders shall be stabilized by horizontal latticed bracings, where required in order to limit the slenderness ratio of the flange to 150.

Generally for girders having span 12m and above, vertical auxiliary girder and horizontal girder at crane girder bottom flange level shall be provided.

At crane girder level, walkway shall be provided on both sides. Walkway at column locations shall have minimum clear width of 600 mm.

All crane girders and their supporting structures shall be designed for loading from loaded crane in worst position of crab and crane to create most unfavourable loading condition of the girders. For increase of load due to impact and crane load combination including lateral surge & longitudinal surge shall be taken as per provision of IS: 875 (Part – 2).

Suitable approach to be provided for tightening of bolts of Crane Rail. Approach for Crane Rail fixing shall be properly planned for all types of sections of Crane Girders.

Surge Girder walkways and auxiliary beams

Continuous maintenance walkways with safety hand-railing shall be provided along each column row adjacent to each crane gantry girder. These walkways shall be of non-slip plate construction connected to crane girder top flange by continuous fillet welds. Access at every 60m shall be provided from floor for access to these walkways so that access is available within 60m from any location.

Connections between surge girder and the main columns shall be designed to resist load due to lateral braking of crane trolley.

On the periphery of the building, full length handrails shall be provided along the edge of the maintenance walkway at crane girder level.

Handrail and its clearance from crane end carriage shall conform to provisions of relevant safety regulations.

Crane stops shall be provided at the ends of each crane girder system, or as required to limit the movement of crane as per technological requirements.

Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

Vertical Deflection

- a) For beams supporting dynamic equipment : Span / 500
- b) For beams supporting floors / masonry : Span / 325
- c) For beams supporting pipes (pipe racks) : Span / 400
- d) For roofing and cladding components : Span / 250
- e) For gratings and chequered plates : Span / 200 subject to a maximum of 6 mm

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

- a) For manually operated cranes & monorails : Span / 500
- b) For electric overhead cranes
 - i) Up to 50 t capacity : Span / 750
 - ii) Over 50 t capacity : Span / 1000

Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

- a) Single storey building (without crane load) : Height / 300
- b) Multistoried building including JTs (without crane load) : Height / 500
- c) Pipe rack columns : Height / 325
- d) Open Structures : Height / 200
- e) Crane gantry girder due to surge : Span / 2000 limited to maximum of 15 mm
- f) Building main columns at crane rail : Height / 2500 limited to

- | | | |
|----|--|---|
| | level due to action of crane surge load only | maximum of 10 mm |
| g) | Open gantry columns at crane rail level due to action of crane surge load only | : Height / 4000 limited to maximum of 10 mm |
| h) | Conveyors, JNTs Conveyor support level, Conveyor support | : Height / 1000 in across direction & Height / 500 in along direction |

Provisions of IS: 800 (Latest Revision) and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

Minimum Thickness of steel elements

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment (exposed to open air i.e. to rain, contact with soil, coal, ash, contact with drained liquid or contaminated water, alkali/acid etc.) shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance. For plate girders minimum thickness of web and flange shall be 8.0 mm.

- | | | |
|----|---|-------------------|
| a) | Trusses, purlins, girts and bracing | : 6 mm |
| b) | Columns and beams | : 8 mm |
| c) | Gussets | : 8 mm |
| d) | Stiffeners | : 8 mm |
| e) | Base plates | : 10 mm & above |
| f) | Chequered plates | : 8mm o/p & above |
| g) | Grating flats | : 6 mm |
| h) | Minimum thickness of structural members other than gratings directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm. | |
| i) | Upto 400 mm depth, Built-up sections shall not be used. | |
| j) | Minimum thickness of base plate for columns at ground level shall be 20 mm (at other levels 16 mm) and minimum thickness of washer plate at any level shall be 0.8 times of Base Plate thickness. | |

Tubular sections not permitted except for parking sheds

Minimum Sizes of steel elements

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for floors of all structures shall not be less than 125 mm.

Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800 (Latest Revision).

The following limiting ratios of depth to span shall be considered as a general guide.

a)	Truss	1 / 10
b)	Rolled beams and girders for Ordinary floors and rafters	1 / 24
c)	Supporting floor beams for vibrating Machinery / equipment	1 / 15
d)	Roof purlins and girts	1 / 45
e)	Gable columns	1 / 30

Expansion joints

Longitudinal and transverse expansion joints shall be provided in buildings and structures in accordance with IS: 800 (Latest).

Expansion joints shall be formed by providing double rows of columns, with overhanging gantry girders, secondary roof and wall framing being detailed to allow the maximum calculated movement for the specified temperature variation.

Miscellaneous Criteria

Natural ventilation shall be provided ensuring that it does not permit rain water entry into the building. Scope of natural lighting shall be used to the maximum possible extent. For this purpose, minimum 15% of side sheeting area and 10% of roof sheeting area, unless otherwise specified, shall be provided with window/ polycarbonate sheets of 4mm thickness (wherever specified). Protective grating shall be provided below such sheets to prevent accidents due to damaged sheets.

DI gutters and DI down-pipes with gutter outlets having grating cover shall be provided to carry rain water from roofs of buildings to the drainage system at ground level. All gutters shall be designed as walkable.

Adequate facilities in the form of monorails, hoists, platforms etc. shall be provided to facilitate repair and maintenance of overhead cranes, equipment, etc. Access to these platforms shall be provided by stairs / ladders from the nearest accessible floor or platform. Wherever the monorail projecting from the building, sliding steel flush doors shall be provided (side hung doors may also be provided depending upon the location).

Edges of floors, gangways, stairs and landings shall be provided with safety hand railings. All hand railings shall be of tubular hand railings with vertical post, top rail and mid rail made up with tubes.

At gable ends of buildings, platforms shall be provided connecting the walkways at crane gantry level.

Connection by permanent bolts to structural elements subject to vibration shall be provided with lock nuts.

Monorails shall be designed for local bending both in transverse and longitudinal direction. The projection of the monorail outside the building shall be as per mechanical requirement.

Chequered plates, Purlins, Side runners, sheeting etc shall not be considered as structural members for transferring horizontal loads. Except where purlins form part of bracing system, designed for axial loads also.

Necessary number of prints of drawings and documents; as per contract shall be submitted for approval.

The slopes of bracings, lacings for columns, diagonal members of trusses, bridges, girders etc shall be kept preferably in the range of 35 to 50 degrees.

Purlins and side runners shall be considered as part of cladding unit and shall be subjected to local wind coefficients as specified in IS: 875.

Structural schematic general arrangement with plans at various levels, elevations along each row and axes, sections, considered loads and load diagrams with location etc. and Structural design drawings with BOQ and Table of members containing design forces along with design calculations shall be submitted for Purchaser's/Consultant's approval. STAAD Pro. file along with editable excel sheets with active formulae to be submitted. However the approval shall be limited to checking of overall dimensions, general stability of system, effective load transfer and deflection limits etc. The approval shall not relieve the contractor of his responsibility of correctness in design, adequacy of connections, accuracy etc.

Shear force at the column base shall be resisted either by shear keys shop-welded to the underside of column base plates or by welding base plate to inserts provided in foundation.

The level of underside of column base shall be so chosen such that the complete anchor table lies below the finished floor level (wherever specified), thus keeping the shop floor free from projections of anchor tables.

Minimum thickness of base plate for columns at ground level shall be 20 mm (at other levels 16 mm) and minimum thickness of washer plate at any level shall be 0.8 times of Base Plate thickness.

All Built-up columns shall be provided with nominal stiffeners to maintain orthogonal & torsional rigidity, at a spacing not exceeding 1500 mm centre to centre

Roof Structures

- a) The main supporting element for roof shall preferably be roof rafters, made of rolled sections or built-up sections, provided at uniform spacing to suit shop layout. Roof shall be provided with adequately sized roof monitor for natural ventilation, wherever required.
- b) For all main technological units / buildings, rafters / roof girders shall be made of I sections either rolled upto 400mm depth or built up above 400mm depth.
- c) Roof shall have suitable slope (1:5, i.e. 1 Vertical: 5 Horizontal, unless otherwise specified) to meet technological as well as rainwater drainage requirements. Hand railings at eaves level and gable ends of the roof of the building shall be provided.
- d) System of bracings shall be provided in the roof top chord and bottom chord levels along with longitudinal ties to ensure stability and rigidity of the roof structures.
- e) Galvanized wind tie (40x6 mm flat) shall be provided at the free edge and ridge portion of roof sheeting. Suitable arrangement of anchors shall be provided at the ridge of roof sheeting for holding lanyards of safety belts.
- f) For design of roof and side wall frame work, purlins / side runners shall be treated as part of cladding unit and shall be subjected to local wind coefficients as given in codes.
- g) Roof drainage system shall be designed for maximum precipitation for 5 minutes based on local meteorological data. In the absence of meteorological data, precipitation of 2mm per minute may be considered for designing drainage system. A factor of safety of 1.3 shall be kept in the design.

- h) All valley and eaves gutters shall be of pressed plate construction with a minimum sole width of 600 mm so as to function as walkways.
 - i) Eaves gutter shall be provided for eaves height ranging between 10 m to 25 m above apron/ground level.
 - j) The gutters shall be laid to slope towards down-pipes with welded outlets and having grills fitted flush with gutter sole. Slope of gutters and collector pipes shall not be flatter than the following limits:
 - i). Longitudinal slope of gutter 1 : 500
 - ii). Longitudinal slope of collector pipe 1 : 300
- Velocity of discharge may be considered as 1 to 2.5m/s. Corrosion factor may be taken as 1.5 mm for designing the gutter plate.
- k) Poking holes with cover shall be provided in the down-pipes at suitable intervals as well as at accessible levels, to clean the down-pipes.
 - l) Eaves gutter shall be provided with safety handrails.
 - m) When rain water falls from higher to lower roof, double layer of sheets shall be provided for the portion of roof sheeting on which rain water falls, provided the drop of roof is in the range of 3 m to 6 m. In case the drop is more than 6 m, independent gutter shall be provided.

Wall Structures

- a) Wall runners with necessary sag rod arrangements shall be provided to support wall and gable sheeting, including internal partition wall, wherever required.
- b) Walls shall be provided with louvers and polycarbonate sheeting at appropriate levels, to provide natural ventilation and lighting.
- c) Adequate framing arrangement shall be provided both in roof and side wall framing, for fixing of ventilator fans / exhaust fans as per requirement.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

VOLUME: II-G/1

SECTION-IV

SPECIFIC DESIGN REQUIREMENTS
[ARCHITECTURAL]



Development Consultants Pvt. Ltd.

Vol. II-G1/Section-IV
Specific Design Requirements- Architectural



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VOLUME: II-G/1

SECTION - IV

**SPECIFIC DESIGN REQUIREMENTS
[ARCHITECTURAL]**

1.00.00 SCOPE

The architectural services shall cover finishing work of power house, Bunker building and all auxiliary buildings, Non-plant buildings included under the specification starting from brick work, partition walls, roof protection, finishing of walls, floors and ceilings, false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement. Chimney are covered separately in their relevant sections.

The **contractor** offer shall cover the complete requirements as per the best prevailing practices keeping in view the statutory and functional requirements of plants & facilities and providing enough space & access for operation, use & maintenance and to complete satisfaction of the owner.

Buildings under scope of work (also refer section 3.00.00 of Volume II/ G-1 Section I):

Plant buildings:

Turbine and its related Auxiliaries

- Turbine Building / Power house building
- CPU Regeneration Building
- ACW Pump house for each unit
- Air Washer Room for each unit on roof of each unit ACW Pump House
- A/c Plant Building and inert gas room
- CST Pump Shed
- DG Plant Shed

Boiler and its related Auxiliaries

- Mill and Bunker Building
- Boiler Maintenance Building
- ESP Control Building.
- Fuel Oil Unloading-Cum- Pressurizing Pump House
- Compressor Shed in Ammonia Storage Area
- Auxiliary Boiler MCC and Control Building.

- MCC / Operator Room for SCR System(Common for all three units)
- RIO-cum-VFD Panel Room
- Plant IA/SA Compressor House

Coal Handling System and its related Auxiliaries

- Receiving Tower
- Crusher House
- Drive House
- Junction Towers
- Conveyor gallery
- CHP Control room cum Switchgear room
- Pump cum compressor house for DSS/DFDS
- Coal Handling system maintenance Building

Ash Handling System and its related Auxiliaries

- Compressor House and Main control room
- Ash water pump house including switchgear room and control room
- Silo utility building cum HCSD Pump House
- Ash water Transfer pump house including switchgear and control room

Raw Water Transfer System

- Raw Water Transfer pump house & switchgear room

Water Pre-treatment & DM Water System

- Chemical House with Treatment Plant/ Lab
- Degassed water storage tank & pump house
- DM plant building with switchgear room, control room
- Clarified Water pump houses with SWGR/MCC Room for PT plant & DM plant
- Pump house for Rain water harvesting Pond.
- PW Chlorination plant building
- UF feed tank & pump house

Circulating Water System



- CW pump house With Switchgear Room and RIO room
- CW Treatment cum Chlorination plant building

Effluent Treatment Plant

- ETP building including pump house and control & switchgear room
- ETP CTBD / RO plant building with effluent disposal system
- ETP reject treatment plant building

Sewage Treatment Plant(2 nos.)

- STP building (2 nos.)

Fire Protection & Detection System

- Fire Water Pump House
- Fire Water Booster Pump House

Switchyard

- GIS Control Room
- GIS Building as per electrical requirement

Hydrogen Generation plant

- Hydrogen Generation building with cylinder storage facility.

FGD and its related Auxiliaries

Limestone based process will be adopted for FGD system. The buildings / structures envisaged are listed below.

Limestone Based System

- Limestone Storage Building/Covered structural steel shed
- Limestone Crusher House
- Limestone Grinding Building
- Absorber Pump & Oxidation air blower House
- Electrical Switchgear & Control Building (FGD main building)
- Gypsum De-watering House
- Gypsum Storage Building /shed



- Junction Tower (If applicable)

Non-Plant buildings:

- Canteen
- Fire Station
- Weigh-bridge (Three numbers)
- Workshop
- First Aid Centre
- Safety office cum stores
- Permanent Stores
- Construction Store
- Car and Cycle / Scooter stand near Service Building
- Rain water harvesting pond.
- Toilet Blocks -one number for CHS area and one number for Boiler area (Separate Building)

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the Power Plant shall be within this scope of work of the contractor.



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Building Description

Building Description									
Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure					Remarks
				Frame / Structure	Floors	Roof	Side Cladding		
Turbine and its related Auxiliaries									
1.	Turbine Building	1	As per layout	Steel	Metal deck with R.C.C	Metal deck with R.C.C	230mm fly ash Brick work side cladding upto 3.0m from FFL and above that double skinned insulated zincalume metal sheet cladding upto roof level to be considered for 'A' row and gable ends. At B row brick cladding will be upto deaerator floor and above deaerator floor double skin zincalume metal cladding upto roof level. On C Row, it will generally be double skin metal cladding above 3m high brick wall above FFL upto roof level of B-C bay. Above 3m level, where brick work is technically required in certain areas like – electrical room etc., single skin zincalume metal cladding will be placed externally covering the brick wall as continuation of metal clad façade.		



Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				Remarks
				Frame / Structure	Floors	Roof	Side Cladding	
2.	CPU regeneration building	1	G+2	Steel	Metal deck with R.C.C	Metal deck with R.C.C	Fly Ash Brick wall cladding	
3.	ACW pump house with Air washer room at roof	3	G+1	Steel	R.C.C. over metal deck	Metal deck with R.C.C	Side cladding shall be by fly ash brick upto 1.0 m height from FFL and remaining part shall be Double skin sheet insulated Zincalume metal cladding	
4.	A/C plant building and inert gas room	1	G	R.C.C.	R.C.C.	R.C.C.	Fly Ash Brick wall cladding	
5.	CST Pump Shed	1	G	Steel	R.C.C.	Sheeting	Single skin, Zincalume metal cladding	
6.	DG Plant Shed	1	G	Steel	R.C.C.	Sheeting	Open	
7.	Plant IA/SA Compressor House near SG	1	G	Steel	R.C.C.	Metal deck with R.C.C	Fly Ash Brick wall cladding.	
Boiler and its related Auxiliaries								
1	Mill &Bunker Building	6		Steel	R.C.C.	R.C.C. on metal deck sheet.	Double skin with insulation Colour coated Zincalume sheet metal cladding	
2	Boiler maintenance building	1	G	Steel	R.C.C.	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding	
3	ESP control building	3	G+3	R.C.C.	R.C.C.	R.C.C.	Fly Ash Brick wall cladding	



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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				Remarks
				Frame / Structure	Floors	Roof	Side Cladding	
4	Fuel oil unloading cum pressurizing pump house	1	G	RCC	R.C.C.	RCC	Fly Ash Brick wall cladding	
5	Auxiliary boiler MCC & control room	1	G	RCC	R.C.C.	RCC	Fly Ash Brick wall cladding	
6	Compressor Shed in Ammonia Storage Area	1	G	Steel	R.C.C.	Steel roofing	open	
7	Electrical room for SCR system	1	G	RCC	R.C.C.	RCC	Fly Ash Brick wall cladding	
8	RIO-cum-VFD Panel Room	3	G	Steel	R.C.C.	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding	
Coal Handling System and its related Auxiliaries								
1	Receiving Tower	1	G	Steel	RCC over metal deck	Metal deck with RCC	Single skin, Zincalume metal cladding fly ash brick upto 1m height with sheet overlap 150mm	
2	Drive House	2	G	Steel	-	Metal deck with RCC	Single skin, Zincalume metal cladding above fly ash brick upto 1m height with sheet overlap 150mm	
3	Crusher House	1	Multi-storied	Steel	RCC over metal deck	Metal deck with RCC	Double skin, Zincalume metal cladding with insulation above 3.0m high fly ash brick wall	



Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
4	Junction towers	8		Steel	RCC over metal deck	Metal deck with RCC	Single skin, Zinalume metal cladding above fly ash brick upto 1m height with sheet overlap 150mm	
5	Conveyor gallery	As per layout	NA	Steel	Chequered plate floor with minimum 8 mm thickness	Single skin, Zinalume metal roofing	Single skin, Zinalume metal cladding	
6	CHP Control room cum switchgear room	1	G+1	RCC	RCC	RCC	Fly Ash Brick Wall	
7	Pump cum compressor house for DSS/DFDS	1	G	RCC	-	RCC	Fly Ash Brick Wall	
8.	Coal Handling System Maintenance Building	1	G	Steel	-	Metal deck with RCC	Fly Ash Brick Wall	
Ash Handling System and its related Auxiliaries								
1	Compressor House including switchgear and Main control room	1	Only G for Compressor House	RCC	-	RCC	Fly Ash Brick Wall	



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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
			and G+1 for Switch gear room					
2	Ash water pump house including switchgear room and control room	1	G	Steel	-	RCC over metal deck	Fly Ash Brick Wall	
3	Ash water Transfer pump house including switchgear room and control room	1	G	Steel	-	RCC over metal deck	Fly Ash Brick Wall	
4	Silo utility building cum HCSD pump house	1	G	RCC	-	RCC	Fly Ash Brick Wall	
Raw Water Transfer system								
1	Intentionally Deleted	!	!	!	!	!	!	
2	Raw Water Transfer Pump House & switchgear room	1	G	RCC	-	RCC	Fly Ash Brick Wall	





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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
Water Pre-treatment & DM water System								
1	Chemical House with Treatment plant/ Lab	1	G+1	RCC	RCC	RCC	Fly Ash Brick Wall	
2	PW Chlorination plant building	1	G	RCC	-	RCC	Fly Ash Brick Wall	
3	UF feed tank & pump house	1	G	Steel	-	Shed with single skin zincalume sheet	Open	
4	DM plant building with switchgear room, control room	1	G	RCC	-	RCC	Fly Ash Brick Wall	
5	Clarified Water pump house with switchgear/MCC room for PT Plant	1	As per functional requirement	RCC	-	RCC	Fly Ash Brick Wall	
6	Clarified Water pump house with switchgear/MCC room for DM Plant	As per functional requirement	As per functional requirement	RCC	-	RCC	Fly Ash Brick Wall	



Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
7	Degassed water storage tank & pump house	1	G	RCC	-	RCC	Fly Ash Brick Wall	
8	Pump house for Rain water harvesting pond	1	G	RCC	-	RCC	Fly Ash Brick Wall	
Fire Protection & Detection System								
1	Fire water Booster PH	As per functional requirement	As per functional requirement	RCC	-	RCC	Fly Ash Brick Wall	
2	Fire water PH	As per functional requirement	As per functional requirement	RCC	-	RCC	Fly Ash Brick Wall	
Circulating Water System								
1	CW pump house with Switchgear Room and RIO room	1	G	Steel	-	RCC on Metal Deck (annex Building roof)	Single sheet Zinalume cladding over 1.0m high Fly ash brick wall from FFL and Fly Ash Brick Wall for annex Building	



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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
						will be RCC)		
2	CW treatment cum Chlorination plant building	1	G	RCC	-	RCC	Fly Ash Brick Wall	
Effluent Treatment Plant								
1	ETP building including pump house and control room	1	G	RCC	-	RCC	Fly Ash Brick Wall	
2	ETP CTBD / RO building with effluent disposal system	1	G	RCC	-	RCC	Fly Ash Brick Wall	
3	ETP reject treatment plant building	1	G	RCC	-	RCC	Fly Ash Brick Wall	
Sewage Treatment Plant								
	STP building	2	G	RCC	-	RCC	Fly Ash Brick Wall	
Switchyard								
1	GIS Control Room	1	G+1	RCC	RCC	RCC	Fly Ash Brick Wall	
2	GIS Building	Number shall be	G	RCC	-	RCC on Metal Deck	Fly Ash Brick Wall	



Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
		as per Electrical requirement						
Hydrogen Generation Plant								
1	Hydrogen Generation Building with cylinder storage facility	1	G	RCC/ Steel	-	RCC on Metal Deck / single skin Zinalume sheet roofing (For storage area)	Fly ash brick work with RCC Jally	
FGD (Limestone Based System)								
1	Limestone Storage Building	1	G	Steel	--	Colour coated Zinalume sheet metal slopped roofing	Single skin Colour coated Zinalume sheet metal cladding above 3.0m high fly ash brick wall.	
2	Limestone Crusher House	1	Multi-storied	Steel	RCC	RCC over metal deck	Double skin, Zinalume metal cladding with insulation above 3.0m high fly ash brick wall	
3	Limestone Grinding Building	1	G	Steel	--	R.C.C. on	Single skin Colour coated Zinalume sheet metal cladding	



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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
						metal deck sheet.	above 3.0m high fly ash brick wall.	
4	Absorber Pump & Oxidation air Blower House	3	G	Steel	--	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding	
5	Electrical Switchgear & Control Building	1	G+1	R.C.C.	R.C.C.	R.C.C.	Fly Ash Brick wall cladding	
6	Gypsum De-watering House	1	G+2(par t plan)	Steel	R.C.C on metal deck sheet	Single skin Colour coated Zincalume sheet metal slopped roofing	Single skin Colour coated Zincalume sheet metal cladding above 3.0m high fly ash brick wall.	
7	Gypsum Storage Building	1	G	Steel	--	Single skin Colour coated Zincalume sheet metal slopped roofing	Single skin Colour coated Zincalume sheet metal cladding above 3.0m high fly ash brick wall.	
8	JT	As per mechanical input	As per mechanical input	Steel	RCC over metal deck	Metal deck with RCC	Single skin, Zincalume metal cladding. fly ash brick upto 1m height with sheet overlap 150mm	





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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
NON-PLANT BUILDINGS								
1	Service building	1	G+4	RCC	R.C.C.	R.C.C.	Fly Ash Brick wall cladding	
2	Canteen	1	G	R.C.C.	-	R.C.C.	Fly Ash Brick Wall	
3	Fire Station	1	G	RCC	-	RCC	Fly Ash Brick Wall	
4	Weigh-bridge	3	G	RCC	-	RCC	Fly Ash Brick Wall	
5	Workshop	1	G	Steel	-	Steel Truss with insulated Sheeting	Single skin Colour coated Zinalume sheet metal cladding above 3.0m high fly ash brick wall.	
6	First Aid Centre	1	G	RCC	-	RCC	Fly Ash Brick Wall	
7	Permanent Stores	1	G	RCC	-	Steel Truss with single skin Zinalume sheet roofing and Annex Building- RCC	Fly Ash Brick Wall	
8	Construction Store	1	G	Steel and Annex	-	Steel Truss with single	Fly Ash Brick Wall	





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Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
				Building- RCC		skin Zincalume sheet roofing and Annex Building- RCC		
9	Toilet blocks Separate buildings (1 no for CHS , and 1 no for Boiler area)	2nos.	G	RCC	PCC M25 Grade 100mm thick over 100mm PCC M10 Grade-	RCC	Fly Ash Brick Wall	
10	Cycle/ Scooter/car stand near service building	As required	G	Steel	-	Steel Truss with sheeting	Open	

Note:- All control rooms shall be of RCC framed construction unless noted mentioned anywhere in the specification.



1.01.00 Codes and Standards

The latest revision of Indian codes and standards as on the original scheduled date of tender opening is applicable unless otherwise stated the latest editions / revision of all related and applicable Indian codes and standards (including IRCs as applicable) along with addendums / amendments, if any, shall be followed. In case the specific Indian Codes and standards are not available, accepted International Codes / standards shall be used.

- National Building Code-2016
- TAC/LPA norms
- Local Fire regulations

2.00.00 DESIGN REQUIREMENTS

2.01.00 Architectural Concepts

- a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building backdrops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.
- b) Main plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.
- c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.
- d) Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements.

- e) Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipment so that the proper co-ordination with other agencies can be taken up at appropriate time.

2.02.00

Architectural Design

- a) Natural light shall be used to the maximum extent especially in the form of north light/skylight. For adequate light and ventilation, National Building Code recommendation shall be followed. However all windows of plant building shall have minimum 1.0 m sill height and bottom of lintel height shall be minimum 2.5 m from finished floor level and Minimum door height shall be 2.5 m.

For all windows of non-plant building shall have minimum 1.0m sill height and bottom of lintel height shall be minimum 2.1 from finished floor level. Minimum door height shall be 2.1.

- b) Entrance canopies, sunshade (projections, recesses) over openable windows and door rolling shutter openings on exterior facades shall be provided.
- c) All the buildings shall be architecturally designed to meet the National Building Code.
- d) All architectural drawings shall be prepared under responsibility of an Architect. The Architect shall be registered under Council of Architecture.
- e) A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology and architectural & civil engineering for a smooth control hierarchy and man machine interface.
- f) Not Used
- g) Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.
- h) All cable spreader floors shall have proper slopes and provision of fire emulsifying system for drainage.
- i) Steel columns within fire hazardous areas like electrical room, Main control room and switch gear room shall be encased with brick work. All steel columns shall have 150mm high concrete base above FFL to ensure proper floor finishing work and to protect the column base.

- j) Minimum 2.1m high headroom clearance has to be maintained at every part of the building including staircases. Vertical Head room clearance shall be maintained as per industry factories Act. Sufficient headroom shall be provided in cable galleries.
- k) Based on functional/system requirements, human access shall be provided with steel grid system (1.2M X 1.2M span) catwalk in the false ceiling system.
- l) Minimum 1.5M wide passage is to be marked on the floor as safety exit route. Such passages shall lead to Fire-escape staircases or fire-safe zones. Doors of fire-hazardous rooms or areas shall open towards safety exit passage. All external doors shall open towards outside. Fire escape staircases shall be located as per fire-code and TAC.

2.03.00 Plant Buildings

2.03.01 Powerhouse Building

Powerhouse superstructure shall be of structural steel framing with RCC floor slabs on permanent colour coated metal deck sheeting and Fly ash Brick Wall & insulated metal cladding construction. Operating floor being the heart centre of Powerhouse shall be designed as a very impressive floor having high quality finish, material and appropriate ambience.

External facade shall be with full brick thick wall up to approximately 3.0m high, plastered and painted. From 3.0m-upto roof external façade shall be clad with factory fabricated Rockwool / PU insulated metal cladding on A Row& Gable ends. At B row brick cladding will be upto deaerator floor.

On C Row, it shall be completely of fly ash brick cladding.

Poly carbonate sheet of 4 mm thick shall be provided along with the metal cladding of Power House building suitably for lighting requirements.

Fire Wall facing towards Transformer yard, shall be as per Electrical/TAC requirements and 250mm thick RCC wall as per Fire Prevention regulation. Single skin metal cladding similar to the Top sheet of Insulated Metal Cladding used for other part of the facia shall be applied over the Fire wall to match the overall elevation treatment. Adequate numbers of fire escape staircases shall be provided in main plant building with fire check doors at each landing as per NBC 2016.

The roof of the TG bay shall be permanent metal decking with in-situ concreting and screed on top and supported on steel truss. The structure is braced in the direction of the crane travel but provided with rigid joints at roof level and framing at other floor levels with the electrical and mill bays in the transverse direction. The roof of the TG Building shall have Electro mechanical roof extractor.

Sufficient natural light and ventilation has to be ensured for every part of the building unless prevented due to technical reasons. Operating floor may have large glazed area made with Structural glazing system. At Crane girder level windows on A Row, B Row and gable ends shall be provided. North Light system shall be provided on roof of power house building at suitable locations so that sufficient natural light can be obtained at TG Hall floor.

Minimum one number down comer shall be provided at each grid column.

Visitor's lounge/gallery provision shall be kept within main control room. Floors in the power house shall have access to the Service Building Floor with a stylish walk way and significant width for ease of material transport.

The contractor shall prepare and submit 3D views of the Power House Building from all sides, with at least three (3) alternatives using different colours and facia treatment/pattern, for selection by the owner.

Architectural Specification of Control Room & Annexure Room

The control room of the Turbine Building is located at Operating Floor level. It is the nerve centre of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience. The control room layout shall be planned/designed in such a way that no intermediate columns within the control room are allowed in order to have a more aesthetic look.

The front look of the control room shall be visually most attractive. The entire façade of the control room along B Row and its side walls are to be treated. These walls shall be clad with Granite slab, ACP of different matching colours or combination of ACP and other suitable matching light weight decorative material.

The room will be fully air-conditioned and have access from T G hall side through Air locks to reduce the noise level as well as heat load. Each Air-lock space shall have two numbers of double leaf glazed sensor operated sliding aluminium doors. The wall facing the turbine hall shall be fully glazed aluminium partition wall with hermetically sealed insulating glass panels. Control room shall have an internal acoustic partition wall along the entire length of the room, facing operating desks. This partition shall be integrated with Digital Display Boards at different locations and have monolithic fabric finishes with high acoustical properties. It will have granite floor, linear metal false ceiling in combination with Gypsum board with A.C and lighting fixtures and wall with acrylic emulsion paint. Necessary arrangement for sealing expansion joints on floor, wall and ceiling has to be ensured. Brief technical specifications of different items to be used for the control room are as follows.

a) Flooring: Flooring shall be heavy duty coloured granite slab (of approved colour and shade) of minimum 18 mm thick of size min. 0.9m x 2m.

b) Skirting: Minimum 150 mm high skirting shall be provided with heavy duty coloured granite slab (of approved colour and shade) of

minimum 18 mm thick of min. 2 m size.

- c) Wall finish: Fly ash Brick masonry walls (rear side of CCR and sides), shall be cladded with Lacquered Glass of 8mm thick minimum of approved colour and design, up to the false ceiling level. Attractive and aesthetically appealing interior scheme with different colours, textures can also be achieved for wall cladding. The colour and design composition of wall cladding is to be submitted for approval of the NLCIL/Consultant before erection.
- d) False ceiling: In order to achieve Hi-Tech appearance of the control room, Gypsum board shall be used in pattern. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS:8183. Under-deck insulation shall be provided as per specification written elsewhere in this document. False ceiling bottom level shall be kept 3500 mm above floor level.
- e) Air lock doors: Sensor operated glazed aluminium door with coloured powder coated finish shall be used having glazing thickness 8mm of clear float glass of approved brand. The doors shall be complete with all necessary hardware as per manufacturer's specification.
- f) Glazed partition wall (facing TG hall): The partition facing TG hall shall be of double glazed insulating glass panels. The glazed partition wall shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling. Insulating glass shall consist of 2 nos. 6 mm thick toughened glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The inner glass for this insulated glass partition shall be of Lacquered glass of approved colour and design. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. The front look of the control room shall be visually most attractive. The entire façade of the control room along B Row and its side walls are to be treated. These walls except for the portion as mentioned above shall be clad with Granite slab, ACP of different matching colours or combination of ACP and other suitable matching light weight decorative material
- g) Internal partition wall of control room: The internal partition wall along the entire length of the room, facing operating desk shall consist of Digital Display Boards at different locations, integrated with wall panels laid flush with the display board and two nos. of matching doors on either sides for access to the rear side for maintenance. This special purpose partition shall have rigid frame work consisting of G.I. Studs of adequate size @ 600 mm c/c and floor, ceiling and intermediate channels to provide a strong wall system capable of supporting wall hung C.C.T.V. at designated locations. The framing system shall be

integrated with independent floor supported structural framework of digital display board so as to cover the entire exposed surface around the board with partition panels.

The front side of the frame shall have Acoustical Panels 2400/1200 x 600 x 19 mm thick of approved colour. The rear side of partition shall have Acoustical Panels of size 2400/1200x600x19mm thick smooth finished with gypsum plaster and finished with acrylic emulsion paint. The entire wall shall have Class I fire rating as per BS code. The partition shall not transmit any load to false ceiling. The entire partition wall shall have concealed framing system and have monolithic fabric finish of approved colour or composition of two different colours as per approved design to entire exposed surfaces including door panels on control room side.

The other internal partitions and wall panelling of the control room shall be of Lacquered glass (8mm thick minimum) of approved colour with high end finishing items wherever transparency is not required. Other internal areas shall be provided with 12mm thick toughened glass.

The **contractor** should prepare and submit interior 3D views of the Control Room and related adjacent rooms like Shift In charge Room, Engineers Room, Conference Room, etc. from all sides, with at least three (3) alternatives using different colours and facia treatment/pattern, for selection by the owner. Control room front 3D views (on B Row) are also to be submitted.

2.03.02 Mill and Bunker Building

This shall be of steel framed structure having metal cladding to clad Bunker Feed Floor double skin with insulation. The colour and pattern of the sheeting shall match the overall ambiance of Power Island. Sufficient natural light and ventilation shall be provided for Bunker Feed floor. Provision of roof access through stair shall be made. Flooring shall be granolithic flooring with metal hardener, windows shall be coloured powder coated aluminium partially fixed and partially sliding type openable window, escape doors shall be fire check doors. Aluminium louvers shall be provided as per HVAC requirement. For sufficient natural light, high level continuous band of polycarbonate sheet shall be provided. Elastomeric waterproofing treatment shall be applied on RCC roof as per technical rule.

2.03.03 **ESP Control Building**

This will be RCC framed structure with fly ash brick clad wall. This will be G+3 storied building having cable spreader room at Ground and second floor and switchgear room and control room at first & third floor respectively. This building shall have toilet facility. Windows shall be coloured powder coated aluminium partially fixed and partially sliding type openable window, escape doors shall be fire check doors. Fire doors shall also be provided for switchgear room and cable spreader rooms. Control room shall have glazed aluminium door. Elastomeric waterproofing treatment shall be applied on RCC roof as per technical rule. For finishing schedule please refer Annexure-I.

2.03.04 **Electrical and Control Building for FGD system**

This will be RCC framed structure with fly ash brick clad wall. This will be G+1 storied building having cable spreader room at Ground and switchgear room and control room at first floor respectively. This building shall have toilet facility. Windows shall be coloured powder coated aluminium partially fixed and partially sliding type openable window, escape doors shall be fire check doors. Fire doors shall also be provided for switchgear room and cable spreader rooms. Control room shall have glazed aluminium door. Elastomeric waterproofing treatment shall be applied on RCC roof as per technical rule. For finishing schedule please refer Annexure-I.

2.03.05 **Other Plant Buildings**

Structures of Other plant buildings shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of each building shall be maintained.

2.04.00 **Non-Plant buildings**

Brief Description of Service Building

The Service Building is a G+4 storied RCC building with filler brick (Fly ash) walls. Building is located adjacent to the Power House Building as shown in the Plot Plan. Minimum 6.0m space between the service building and power house building shall be kept for Approach road. An all-weather covered access corridor to be provided with powerhouse building at operating floor level and at mezzanine floor level. Two levels of both PH Bldg & (0 M & Operating floor of PH Bldg) the Service building floor shall match with 0.00 M & TG Operating floor. Accordingly all the other floors of Service Building will be decided during detailed engineering keeping uniform floor to floor height. The floor levels of Service building are indicative only. Any modification required in service building levels based on Final TG Operating floor levels will be discussed and finalized during detail engineering. Overall area of the building shall be approximately 7000 Sqm. However the building size shall be

suitably decided during detailed engineering stage. It will have different offices and other facilities in different floors as per O&M requirement of the owner. This building will house O&M staff, laboratories for relay testing, electrical testing, C&I repairs and transmitters besides provision of computer room, conference hall, model room, archives, change room with lockers, telephone exchange, battery room, reception, stores, pantry etc. Building shall have 1 (one) Passenger elevator (8 passenger), 1 (one) main staircases and 1 (one) fire escape staircase. Overhead water tank of 10,000-litre capacity - 5000 (5X1000) lit service water and 5000 (5X1000) lit potable water shall be provided at roof of the building. Ground floor slab will be RCC floor with sub-grade as per technical rule.

It is an important part of operation and maintenance of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience.

Details of Major Non-Technological Facilities / Rooms at Various Floors are given below:

Floor	Functional spaces
Ground Floor (0.00Mtr Lev) (General Floor)	Reception room
	Security room
	Display room/ model room
	Meeting room
	Conference room (suitable for 50 persons)
	Telephone room
	Library cum Documentation room
	First Aid Room
	Toilet
	Pantry room and dining hall
First Floor (Civil Floor)	Chief Engineer
	Dy. Chief Engineer (Civil.)
	Dy. Superintendent
	Executive Engineer
	Engineers Room
	Store
	Meeting Rooms
	Civil Maintenance Room
	Dy. Superintendent R&I
	Pantry room and dining hall
Second Floor (Electrical Floor)	Toilet
	Chief Engineer (Electrical)
	Dy. Chief Engineer (Electrical)
	Dy. Superintendent
	Executive Engineer
	HT & LT Cable
	Meeting Room
	Meeting room
	Engineers room

Floor	Functional spaces
	Store
	Electronic Lab.
	Computer Room
	Record Room
	Running maintenance room
	General maintenance room
	Toilet
	Express Lab
	Pneumatic Lab
	Measurement & Analyzer Lab
	Electrical Lab
	Pantry room and dining hall
Third floor (Mechanical Floor)	Chief Engineer (Mechanical)
	Dy. Chief Engineer
	Dy. Superintendent
	Executive Engineer
	Meeting room
	Stores
	Turbine (Staff)
	Boiler (Staff)
	BMS Lab.
	Computer Room
	Running Maintenance room
	General maintenance room
	Pantry room and dining hall
	Toilet
Fourth Floor (C&I Floor)	Chief Engineer (C&I)
	Dy. Chief Engineer
	Dy. Superintendent
	Executive Engineer
	Meeting Room
	Engineers room
	Store
	Electronic Lab.
	Computer Room
	Record Room
	Running maintenance room
	General maintenance room
	Toilet
	Express Lab
	Measurement & Analyzer Lab
	Simulator room and battery room
	Pantry room and dining hall

Following additional facilities shall be provided in service building:

- i) Separate toilets for ladies, gents as well as physically challenged persons shall be provided & shall have on each floor of service

building. Attached toilets will be provided for all senior executive rooms and conference rooms. The facilities provided in the toilet shall depend on the number of users. IS: 1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS: 2064 and IS: 2065 shall also be followed.

- ii) Unless otherwise specified, the facilities shall be based on the stipulation of NBC. Exhaust fans of suitable ventilation capacity will be provided in toilets.

Gents Toilet

- a) All the facilities such as WC, Urinals, wash basins etc. shall be based on occupant load as per NBC and shall be of approved colour. However minimum requirements are given below.
 - b) WC (Indian type) (minimum 580x440mm) as per IS: 2556 (Part-3) with all fittings including health faucet, flushing arrangement of appropriate capacity and type – 1 no.
 - c) WC western type as per IS: 2556 (part 2) with toilet paper roll holder and health faucet and all fittings including flushing system of appropriate capacity and type – 1 no.
 - d) Urinal (IWC for ladies toilets) with all fittings including partition with photovoltaic control flushing system as per IS: 2556 (Part-6, Sec.1) – 2 nos.
 - e) Wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with min. 18 mm thick polished granite stone – 2 nos.
 - f) Wall to wall Bathroom mirror (5.5 mm thick float glass) with beveled edges including all fittings – 2 nos.
 - g) Stainless steel towel rail (600 x 20mm) - 2 nos.
 - h) Stainless steel liquid soap holder cum dispenser – 2 nos.
 - i) Janitor room.
 - j) Installation of water cooler of adequate capacity.
 - k) Provision of ventilation shaft.
- iii) Ladies toilet will be provided with items b), c), e), f), g), h) , i)& k)
- iv) Attached toilets provided for senior executive rooms and conference rooms shall have 1 EWC, 1 urinal, 1 washbasin, 1 mirror, 1 no. Towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type

390 mm high as per IS: 2556(Part-2) with toilet paper roll holder and health faucet and all fittings including flushing valve of appropriate capacity and type.

- v) All plumbing, sanitary fittings, connections and service lines shall be provided as per requirement. All service lines, water supply, plumbing lines and other utility lines shall be concealed within the brick /concrete work and removable wooden panels shall be provided at intervals for access. Two stack systems shall be provided for the toilets.
- vi) False ceiling shall be provided in the A/C rooms like conference rooms, higher official's rooms, corridors, etc.
- vii) RCC staircase with stainless steel 40 mm dia pipe hand railing with vertical post shall be provided. Fire escape stair(s) is to be suitably located. All stairs shall be provided upto roofs.
- viii) Entrance canopy as portico at ground floor entrance shall be provided.
- ix) Aluminium Doors, windows, ventilators etc. shall be provided to suit requirements as per Architectural / Technical rule.
- x) Inserts and cut outs shall be provided to suit requirement.
- xi) PCC apron shall be provided in slope all round the building with side drains.
- xii) Suitable access road shall be provided for the building.
- xiii) A central Courtyard shall be provided with vents at higher levels / solar chimney arrangement, to draw away the rising hot air. The effect of various chajja-fin combinations shall be explored to reduce the heat gain. Service building shall have a circular atrium with walkway all around. Accordingly, a circular dome shall be used as roof for atrium portion. Central atrium / courtyard shall be provided with Translucent Polycarbonate sheet
- xiv) Sufficient live / dead load to install the solar panels shall be taken care of in the design of the roof of the service building shall be considered to facilitate installation of PV power generation system for the service building at a later date.
- xv) For external colour and texture, a smooth and light coloured surface that reflects heat and light, shall be considered. White and light shades have higher solar reflectivity and therefore are ideally used for reducing heat gain in the summer months.

- xvi) For the air-conditioned areas the glazing shall be tinted toughened insulated glass of Minimum 24 mm thick (6mm + 12mm air gap + 6mm).
- xvii) Shaded Parking lot adjacent to service building shall be provided for parking two and four wheelers, with adequate space for planting trees all-round.

The **contractor** shall prepare and submit 3D views of the Service Building from all sides, with at least three (3) alternatives using different colours and facia treatment/pattern, for selection by the owner.

The Building will be centrally air-conditioned. All finishing items, Layout, and other requirements shall be of owner's choice. However modern design approach of an office building like- open & flexible (workstation based) layout, usage of natural light, solar control, energy efficient, etc. shall be considered. Since this is one of the most prestigious buildings, aesthetically this shall achieve landmark quality.

Specially designed long and spacious RCC porch shall be given in front of the main entrance for receiving cars of VIP's.

Special attention to be given for area development and landscaping in front of service building with flowering plants and fountains etc.

Shaded car parking, cycle & scooter parking facility shall be provided as per requirement of the owner

Brief technical specifications of different items to be used for the area as follows:

a) Flooring

Generally floor finish shall be Non-skid, fully vitrified, of Class-I quality 10/11 mm thick or as per manufacturer non-porous, homogenous, and abrasion resistant, floor tiles, of minimum size minimum 600 mm x 600 mm of approved colour & design, and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles, under bed.

For Entry cum reception lounge, VIP lounge, Main meeting/ conference room:-Suitable and approved combination shaded of granite slab and strips shall be used. Floor pattern shall be approved by the owner before erection.

For staircase and Corridors:

Steps-risers & tread, stair skirting, corridor floor shall be combination of two matching shade of granite slab and strips. Wall cladding of Elevator Lobby shall be of polished granite tiles(12mm thick minimum) of approved shade by owner. Stainless steel hand rail and balustrade of approved design shall be

used.

For Toilet:

For flooring Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 50 mm thick) and with glazed ceramic tile of same make for walls, Dado shall be 100 mm higher than bottom of lintel level. Only for toilet at operating floor and Third floor, dado shall be topped with 50 mm wide matching moulded ceramic trims.

For other areas like AHU room, Generator room, Electrical room, Etc.: shall have 50 mm thick heavy duty cement concrete granolithic floor with metallic hardener and matching skirting

b) Wall finish

Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the plastered masonry surface prepared with White Cement Putty for all area Front wall for elevator shaft shall have polished granite slab wall cladding (min 12 mm thick).

Painting to exterior surfaces of wall shall be painted with Exterior quality Acrylic Emulsion Paint over suitable primer. To accentuate the building façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used.

c) False ceiling

It will be applicable for all areas excluding non A/C areas like AHU room, Generator room, Electrical room, etc., pantry and toilet. It shall be of aluminium linear acoustic false ceiling with rock wool insulation on top similar to LUXALON having approved colour with stove enamel finish, and or Mineral fibre board and or Gypsum MR board as per functional requirement and interior design scheme, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.

For pantry and toilet false ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm.

The minimum ceiling height of air conditioned area of each floor will not be less than 3.0m (up to bottom of false ceiling).

d) Doors

Double acting glazed aluminium door with minimum 15 micron colour powder coated finish shall be used having glazing of clear/tinted float glass of approved brand. The doors shall be complete with weather seal, gaskets, floor spring, door stopper, door locks, push/pull bars of similar finish and all necessary hardware. Glazed partition may be etched with suitable and approved designed. Wooden doors shall be of factory made solid core wooden flush door with C. P. Teak veneered surfaces in wooden frame with

wooden architrave. The door frame shall be of Teak Wood.
Toilet & pantry doors shall be hard core FRP door.

Doors for areas like AHU room, Generator room, Electrical room, etc. shall be hollow metal flush door.

e) Glazed Panels

The glazed panels shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels (between AC and non-AC areas). This partition height shall be from top of floor finish to the bottom of the false ceiling and maximum available width. Insulating glass shall consist of 2 nos. 6 mm thick clear float glass separated by an air gap of 12 mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather-proof complete with gaskets, clips, hardware, etc.

Glazed partition may be etched with suitable and approved designed.

f) Windows, Glazed Curtain wall

All windows of A/C areas shall be separated with double insulated glass from non AC areas. Other windows shall be 15micron thick colour powder coated aluminium glazed window with minimum 6mm thick clear float glass. Glazed curtain wall shall be Unitised structural glazing system comprising of 30 micron colour anodised aluminium extrusions with double insulated heat reflecting glass. The system shall be able to withstand wind pressure as per relevant data given elsewhere in this specification at all heights.

g) Utilities

All utility lines like water supply line, Electrical wiring, telephone line, etc. shall be concealed type. Fittings and fixtures for toilets shall be of best quality and to be got approved by Owner prior to installation. Roof treatment, sanitary & sewerage system, roof drainage etc. shall be as per detail technical specification.

- h) Any other items of work not specifically mentioned here shall be as per the guidelines indicated in relevant Architectural Technical Specification. Simulator room shall be provided with all the facilities as per technological requirement (minimum 100 sq.m) with aluminium glazed partitions, false ceiling, AC facilities etc. If battery rooms provided Acid / alkali resistance tiles for floors and dado (mentioned elsewhere) shall be provided.

Brief Description Canteen Building

- a) This shall be single storey RCC framed structure with fly ash brick cladding. Spacing of columns shall be such that large column free areas are available in the dining area.

- b) The dining area shall be fully air-conditioned and with gypsum board false ceiling to accommodate minimum 100 people at one time (Separate accommodation for Permanent employees 50Nos and Separate accommodation for Contract workers 50Nos) and in addition there shall be a separate accommodation for 25 executives
- c) Adequate space shall be provided for stores, preparation, cooking, serving and washing facility.
- d) Toilet and hand wash shall be kept sufficiently away from cooking area to satisfy statutory requirements.
- e) Walls of the dining hall, cooking and serving area shall be given dado of glazed ceramic tiles as per the Finishing Schedule.
- f) Adequate exhaust fans and ventilation facility shall be given in the cooking area.
- g) Special arrangement shall be made to lead off the wastewater from canteen to the effluent treatment plant.
- h) Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. Doors of other areas shall be wooden panel door, hollow metal flush door as applicable.
- i) All windows shall be glazed aluminium window.
- j) Fuel/Gas store shall be kept away from canteen block as per statutory rules.

Brief Description of Fire Station Building

- a) Fire station shall be a single storied RCC framed building with fly ash brick walls in office area.
- b) The fire station shall have provision for parking for fire tenders (Nos, as per Mechanical Volume) including one bay for maintenance with pit, office for the station-in-charge, duty room, control room, office, stores, class room, record cum general room, toilet facilities, tool room, spare parts room, recreation room, dining with kitchen, etc.
- c) Parking area for tenders shall ensure fast movement of the fire tender in an emergency.
- d) In addition, adequate space shall be provided for hose drying and drill at ground level with water tub.
- e) The arrangement shall in general satisfy requirement of the Standing Fire Advisory Council or local fire brigade.

Brief Description of Weigh Bridge Control Room (for all weigh bridges)

- a) These shall be RCC framed structure with RCC roof and fly ash brick cladding.
- b) Adequate aluminium glazed windows with MS grill shall be provided for ventilation & lighting.
- c) Roof shall be given water proofing treatment.
- d) Hollow metal pressed steel doors shall be used for personnel movement.
- e) Toilet facilities shall be provided.
- f) The weighbridge control building shall be as per vendor's input, but shall not be less than 6.0 m x 3.0 m.

Brief Description of Workshop (ERS, ETL, Mechanical Repair Shop)

- a) The workshop shall be structural steel building with fly ash brick wall cladding up to 3.0 m from FFL. Wall cladding above this and roof shall be of insulated metal cladding with zincalume sheeting.
- b) The workshop shall have provisions as specified in the **Contract** drawing 18A03-DWG-M-007.
- c) Flooring shall be of metallic hardner surface over RCC floor except toilet area.

Brief Description of the First Aid Centre

- a) This shall be single storey RCC framed structure with fly ash brick cladding. Spacing of columns shall be such that large column free areas are available in the reception cum waiting area.
- b) This building shall be comprised of
 - Waiting Hall cum reception
 - Dispensary
 - Medicine Store
 - Doctor's consultation room with attached toilet
 - Nurses change and locker room
 - Nurses station
 - 2 Bedded trauma room with toilet
 - Ladies and gents toilet and toilet for physically challenged.

- Room for general staff & driver's rest room
- Pantry room
- c) Space shall be provided for eyewash and washing facility and one number Ambulance Parking
- d) Walls shall be given dado of glazed ceramic tiles to a height as specified in the Finishing Schedule.
- e) Special arrangement shall be made to lead off the wastewater from Medical Centre to the effluent treatment plant.
- f) Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. Doors of other areas shall be wooden panel door, hollow metal flush door as applicable.
- g) All windows shall be glazed aluminium window.

Brief Description of Permanent Store

- a) This will be cluster of building blocks, fly ash brick clad of RCC framed structure with RCC roof for annexed buildings and RCC structure with fly ash brick wall and metal sheet roof roofing for main store building, as per structural design consideration. Total area of the Permanent store shall not be less than 6000 sqm.
- b) Heavy and Light material store buildings shall be Steel structure with 3.0m high fly ash brick wall and balance insulated zincalume metal cladding and the sheet roof . In the heavy material storage area, electric hoist of adequate capacity shall be provided. There shall be part mezzanine floor for Heavy and Light Material store buildings.
- c) Store building shall have facility to store heavy materials, light materials, electronic equipment & parts, etc. and provision for storage bins with fork lift movement area shall be kept.
- d) RCC framed with RCC roof structure shall be for Precision Material, Medicine, etc. Store building and Office Building block. This block shall also provide for office space for superintendent and his supervisory staff, locker room and change room for workers, toilets & drinking water facility, record room, challan receipt and issuing counters, etc.
- e) Entry and exit of trucks shall be through adequately sized rolling shutters. In addition a minimum 2 single leaf steel flush door for each store shall be provided for entry of the staff. Three Store Houses shall be separate buildings with a sufficient gap in between for truck movement.
- f) Adequate windows shall be provided for ventilation and lighting. Offices inside shall be of glazed partition above 900 mm high single

fly ash brick wall. Total height of partition including brickwork shall be 2400 mm. Doors to the cabins shall be of glazed aluminium.

- g) Gypsum board false ceiling shall be provided for AC areas.
- h) Store complex shall have chain link fencing with in & out Gate under security surveillance.
- i) There shall be weigh bridge facility attached to main office of 60T capacity exclusively for this Permanent Store with mini control room.
- j) There shall be shaded or open air storage yards within this complex.
- k) Necessary approach roads shall also be provided.
- l) Toilet facilities shall be as provided as per specification.

Brief Description of Construction store

- a) This shall be single storied building with metal sheet roofing over steel truss and steel column support. Building shall be fly ash brick wall clad. However the annexe building shall be of RCC construction.
- b) Total area of the store shall not be less than 1000 SqM. However the size, number of stores, internal divisions, etc. shall be as per quantity of material to be stored for a stipulated time period.
- c) The buildings shall consist of large storage space with provision for forklift entrance.
- d) Provision for office with toilet facility shall also be provided.
- e) Ceramic tiles dado shall be provided up to 100mm high over the lintel for toilets and pantry. Toilet facilities shall be provided as per specification.
- f) For storing of any precision material or as the case may be, AC store facility is to be constructed within the store building or a separate store building as per owner's direction.

General

All the non-plant buildings shall be provided with Plinth protection, garland drains, access to roof through stair, roof treatment, RCC parapet, UPVC down comers, approach roads as per the architectural requirements.

Car Scooter Parking near Service Building

Covered parking for minimum 20 nos. cars and for minimum 50 nos. two-wheelers & cycle shall be provided as per requirement at the desired location

of the owner. Structure shall be of Steel structure with zincalume metal roofing. The structure shall be aesthetically harmonious and attractive. Paving shall be with Heavy duty interlocking paver blocks as per the architectural requirements. Edges of paver block shall be protected with 300 mm wide and 100 mm thick PCC M15.

Brief Description of Safety Office cum store

RCC building, having 150 sqm minimum plinth areas which shall consist of officer room, general store compartment and visitor room with in the building.

Framing shall be off RCC, Roof shall be of RCC without metal deck and Side cladding shall of fly ash brick work.

Finish schedule :

Floor: 10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern with matching skirting.

Wall : Acrylic Emulsion paint over white cement putty

Ceiling: Acrylic Emulsion paint.

Door : Aluminium glazed door

Window: Powder coated and UV protected Aluminium glazed window / ventilator.

Toilet (Gents & Ladies).

Floor : 10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern.

Wall: ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.

Ceiling: Acrylic Emulsion paint

Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.

3.00.00 ARCHITECTURAL REQUIREMENTS

3.01.00 Roof Insulation and Ventilation

The roof of buildings which are recommended by HVAC department for insulation shall be under deck insulated as per specification given elsewhere in this document. The roofs/floors housing manpower and precious equipment/instruments and AC rooms exposed to heat environment shall be

provided with underdeck insulation with false ceiling.

Extractor fans will be provided over roof of turbine hall for ventilation. For ventilation requirements relevant section of the specification shall be referred.

3.02.00 Roof Waterproofing

Roof waterproofing treatment shall be as per Cl. No.:4.00.00.13

Where technically necessary from HVAC requirement, under deck insulation of required material and thickness shall be provided as per technical specification.

3.03.00 Main/Partition Wall

All main/intermediate walls shall be full brick thick wall in 1:6 cement sand mortar. Half brick thick wall in 1:4 cement: sand mortar with 2 nos. 6 mm dia. rod in every fourth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided with structural steel member at minimum 2.5 m clear height with MS inserts/lugs for anchoring in brick work shall be provided. Similarly MS lugs shall be provided on the structural member at spacing 500/600 mm on vertical face for proper anchorage for brickwork, lugs embedded in concrete and suitable vertical structural member at maximum 5m c/c. Full glazed partition in anodized aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area. Half brick thick wall shall be permitted in toilet area and shelf supports in other buildings.

3.04.00 Plastering

All fly ash brick walls, ceilings shall be plastered as below:

Exterior & rough side of interior brick wall	20 mm thick minimum sand faced plaster with 1:4 cement-sand mortar in two layers.
Interior wall	12 mm thick with 1:4 cement-sand mortar
Ceiling	10 mm thick with 1:3 cement-sand mortar shall be provided to all exposed ceilings. Generally river sand confirming to IS 383 shall be used. However the engineer-in-charge of the works may permit use of M sand confirming to zone II in case of non-availability of river sand.

3.05.00 False Ceiling

False ceiling shall be of either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details.

Areas like office space or where specified, Mineral Fiber Based Acoustic Ceiling Board, in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative, Moisture & Fire Resistant Gypsum Board false ceiling system may be used as per the manufacturer's specification and wherever specified.

Under deck insulation is to be provided in air-conditioned areas as per HVAC requirement.

All air-conditioned control rooms (wherever located) shall be provided with under deck insulation irrespective of the type (MOC) of false ceiling. Control rooms shall have Air lock facility (Double door) as per Electrical requirement.

The false ceiling work shall take care of all illumination, fire detection & fire fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS:8183 over the false ceiling panels. Wherever under-deck insulation is required the insulation shall be fixed to the ceiling slab and shall be as per specification mentioned elsewhere in the specification.

3.06.00 Special Finish

- a) The main entrance of powerhouse, Service Building, control room shall have high quality aesthetic finish to entrance, floors, walls, ceilings, etc. as mentioned in this specification.
- b) The main entrance of control rooms and following buildings shall have high quality aesthetic finish to entrance, floors, walls, ceilings etc.
 - Canteen
 - Fire Station
 - First Aid Centre
 - Permanent Stores
- c) The main entrance of ESP control room building shall be finished with granite stone slab and RCC stairs shall be finished with granite slab with SS hand-railing. For other finishes refer Annexure-I.

3.07.00 Doors

- a) Generally factory made hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.
- b) Factory made Solid core wooden flush doors in teak wood frame shall

be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

- c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings-9.0 Sqm and above- are required. Rolling shutters shall be electrically operated. Wherever truck entry is envisaged, minimum size of rolling shutter size shall not be less than 3.5m (W) x 4.0m (H).
- d) Control rooms and other office area shall be provided with minimum 15 micron pre-coated i.e. coloured powder coated aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems . Two sets of doors with sensor operated door shall be provided for main control room.
- e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard, electrical rooms and also to all fire exists as per NBC and TAC requirement.
- f) Doors shall be provided at appropriate location to prevent dust ingress from outside.
- g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core FRP.
- h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

3.08.00 Windows & Ventilators

Full glazed windows and ventilators shall be in minimum powder coated and UV protected aluminium window frame shall be provided with 6 mm thick clear float glass and 5.5mm wired glass wherever required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators.

Glazing between AC and Non AC areas shall be Double insulated glass. Aluminium sections shall be of heavy duty and from reputed and approved manufacturer. Windows and ventilators shall be fabricated and painted by the reputed fabricators at their own fabrication shop. The window area shall be so decided as to allow adequate natural ventilation and light.

Note: Member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the **Contractor** before execution.

3.09.00 Landscaping

All non-plant Buildings area including its Car Parking shall be accentuated with suitable landscape design.

3.10.00 Facilities in Buildings

Adequate toilet and drinking water facilities shall be provided for personnel working in each building. Each building shall have toilet facilities both for Gents and Ladies and physically challenged persons. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code. Minimum area requirement for Gents toilet shall be of 15 m² and Ladies toilet shall be 12 m².

However minimum 1 EWC with health flush with cistern and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, minimum 2 urinals shall be provided in each gent's toilet and above fixtures without urinals in each ladies toilet.

1 EWC with hand rest with health flush with cistern, 1 washbasin with mirror, towel rail and soap case shall be provided in each physically challenged persons Toilet shall be provided in all floors of Main Plant buildings and service building and buildings wherever mentioned.

Each floor shall have drinking water facility connected through potable water with water cooler.

Each floor of TG and service buildings shall have toilet facility of adequate size for gents & ladies and physically challenged persons.

All buildings shall be provided with HDPE (white colour) roof potable water tank (except Power House where it is RCC internally lined with glazed ceramic tiles) of adequate capacity (2 days storage or 1000 liters capacity whichever is higher) as per total requirement of plumbing fixtures. Separate tanks of minimum 1000 liters capacity shall be provided for service water as specified elsewhere in the specification.

Attached toilet 1 EWC with cistern with health flush, 1 washbasin with mirror, towel rail, soap case, shall be provided to the Senior Executive Office rooms in Service Building.

Each floor shall have drinking water facility connected through potable water with water cooler.

Provisions shall be kept for barrier free environment for physically challenged persons like ramps in 1 in 12 slope, lifts, toilets, etc. The main entrances of all the plant buildings shall be provided with ramp.

Pantry provision shall be kept at ground floor and operating floor of power house building, all floors of service building and the areas which has office space, control room or the spaces which will be 24 hours manned.

3.11.00

Potable Water System and Service water Plumbing

This system for various buildings shall be connected to the drinking water and service water systems, the scheme for which is indicated elsewhere in this specification.

Water outlets shall be provided for an instantaneous flow rate of approximately 7Cu.M/Hr.(25GPM).

System will satisfy state and local plumbing codes. Following I.S. Codes for the system shall be followed:

- a) IS-2065: Code of Practice for water supply in buildings.
- b) IS-1172: Code of basic requirements for water supply, drainage and sanitation.
- c) IS-1200: Laying of water and sewer lines including appurtenant items.
(Pt.XVI)
- d) IS-1239 Specification for mild steel tubes and mild steel tubular and other wrought steel pipe fittings. (10mm to 15 mm nominal diameter).
- e) IS-3589: Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

Potable water shall be supplied to wash basins, sinks, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the yard sanitary sewer system.

Service water shall be supplied to water closets, urinals and other plumbing fixtures.

3.12.00

Roof Drainage Systems

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

- a) Roof Drain Heads
- b) Rain Water Down comers
- c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this purpose.

Adequate numbers of rain water drain sheds shall be provided for all roof areas as per standard norms for roof area.

System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.

All RCC roof buildings shall have access through staircase for cleaning of roof drains. Roofs with solar panels shall be accessible through staircase.

Roof drains will conduct water to storm sewers. No rainwater pipes shall be exposed to outside view.

All the drains including plinth protection drains shall be of RCC.

3.13.00 Glazing & Glazed Partition

- a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.
- b) 6 mm thick ground glass shall be provided for toilets.
- c) Glazing between two A.C. areas shall be with 8 mm thick clear float glass.
- d) All glazing shall be in aluminium frame having 15-micron colour powder coated.
- e) 5.5 mm thick wired glass shall be used for windows/ ventilators at higher level for safety.
- f) 24 mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6 mm thick clear float glass on inner side with 12 mm main gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.
- g) For glazed aluminium door, 8.0mm thick clear float glass with or without etching is to be provided

3.14.00 Sealant

Silicon sealant around external doors and windows and Polysulphide sealant with polystyrene filler board shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows, and expansion joints, etc. shall be sealed for proper water-lightness.

For expansion joints more than 50mm width special type expansion joint control system with extruded aluminium sections and EPDM membrane shall be used on exposed vertical faces of the expansion joints after sealing, extruded aluminium special type of flashing shall be provided.

3.15.00 Damp Proof Course

40 mm thick 1:1.5:3 concrete with 12mm Blue Granite Chips and 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.16.00 Plinth Protection

Minimum 1000 mm wide (excluding drain width) and minimum 100 mm thick P.C.C. M 20 plinth protection along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be provided. The plinth protection shall be laid over prepared sub-grade and base formed with two layers of locally available broken laterite stone/ stone boulders. Each layer shall have a pre-compacted thickness of 150 mm and consolidated to 115mm. Thus the total thickness becomes 230mm.

3.17.00 Miscellaneous Metal Railing

- a) For main stair & lobby of Powerhouse building up to operating floor and one half landing above operating floor, around large openings at operating floor, shall have SS Hand rails of 40mm diameter stainless steel railing and post, with minimum 3mm wall thick & decorative seamlessly joined.. Stainless steel pipe handrail in shall be of grade SS-304 and of approved design to meet the functional requirement as well as very good aesthetic appearance. Other hand railings of Power house building shall be MS Galvanised hand railing with 40 mm NB (medium) main post and 40 mm NB (medium) as horizontal rails. With toe guard shall be provided.
- b) For important non-plant buildings like Service Building, stainless steel railing with SS posts & decorative SS handrails shall be provided.
- c) Hand railings of Plant building shall be MS Galvanised (as per IS 4736) and finished with suitable paint hand railing with 40 mm NB (medium) main post and 40 mm NB (medium) as horizontal rails, as per IS-1161, with toe guard shall be provided.

3.18.00 Painting

Exterior Masonry Surface : Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint 2 coats over approved primer. Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade. Aluminium composite panels (ACP) may be used to accentuate certain portion of the façade or certain element of the façade as the case may be.

Exterior Steel Work	: refer relevant clauses as specified elsewhere
All Woodwork	: Synthetic paint 2 coats over a coat of primer.
All Internal Steel Work	: Refer relevant clauses as specified elsewhere
Steel in contact with acid /alkali	: Chemical resistant paint
All interior masonry surfaces	: Interior Acrylic emulsion paint over 3mm Thick white cement putty punning.
Fire Door	: Post Office red shade shall be provided.

3.19.00

Miscellaneous Work

- a) Counter tops in kitchen, Washbasin, pantry & similar areas shall be polished granite over RCC slab.
- b) Walkways etc. shall be of heavy duty 75 mm (minimum) thick anti-skid interlocking concrete paver blocks with a minimum compressive strength of 30MPa of approved design and top colour.
- c) For windows, powder coated aluminium grill shall be provided. But in specific cases, M.S. grills shall be used as per approved design for security purpose made of 25 mm X 6mm M.S. Flats / 12mm – 20mm M.S. square bar of approved design shall be provided to suit security requirements.
- d) For RCC main stair and landing of powerhouse building shall be of Granite slab with all edges and nosing moulded, RCC stair of other plant and non-plant buildings shall be of Kota stone and white marble strip combination with all edges and nosing moulded.
- e) RCC staircase shall be provided in main entrance of Turbine building, Facility building and other important buildings. R.C.C. stair railing shall be with Stainless Steel handrails and balusters shall be provided . Other staircase shall be provided with Structural steel work.
- f) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.
- g) Suitable arrangement of floor drain with trap shall be provided in ground floor and for elevated floors, drainage arrangement shall be provided with necessary slope and trap in floor where spillage of water / floor washing will occur.

- h) Near Service Building, covered car parking stand for 20nos cars module with minimum 75mm thick coloured interlocking cement concrete tile flooring with a minimum compressive strength of 30MPa over reinforced concrete hard standing and module for 50 nos. Two-wheelers & cycle parking stand shall be provided as per requirement at the desired location of the owner. Structure shall be of Steel structure with zincalume metal roofing. The structure shall be aesthetically harmonious.
- i) Doors, windows and rolling shutter in all buildings shall have sunshade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 600 mm for windows. Projections for Rolling shutter shall be 1000mm. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided.
- j) North Light provisions on the powerhouse shall be made of Polycarbonate sheet fixed to structural framework as per approved design. Arrangement shall have to be provided to prevent ingress of rainwater if any.
- k) Roof access: All roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. (buildings more than one floor i.e. G+1 and above shall necessarily be provided with staircase) Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.
- l) Window sill: All window sill height shall be measured from finished floor level.
- m) Lintel height: All lintel height shall be measured from finished floor level.
- n) Parapet height: All RCC roofs shall have minimum 1000mm high parapet wall. Parapet wall shall be of RCC and shall be of 125mm thickness.
- o) Internal wall height: Wall height between AC and Non AC areas as well as between two AC areas, shall be full height up to bottom of roof slab or bottom of beam.
- p) False ceiling height: Unless specifically mentioned the false ceiling height shall be 3.m within rooms and 2.7m-3.0m at corridors outside the rooms.
- q) Floor opening: Any uncovered floor opening more than 0.3sqm in area shall have 150mm high RCC kerb all round and shall be protected with minimum 1000mm high railing.

- r) Dado/Skirting height: Unless specifically mentioned the skirting height shall be 150mm from finished floor level and dado height shall be 100mm higher than the door opening height for toilets and kitchen / pantry.
- s) All RCC flat roofs as per electrical requirements, shall have adequate provision for erecting Solar Panels as per manufacturer's erection and anchoring specification and also as per civil design (It may be considered in design, the panels will be erected over the entire area of roof). Loading due to panels (Self weight, Wind etc. as applicable) shall be considered in the design of all buildings. Water point shall be provided over the roof for cleaning of panels etc.
- t) Scheme to be made and executed rainwater harvesting system for the entire plant area. From individual building roof, rainwater shall be collected through down comers and Rain water from other open areas let into drains and finally conveyed to Rain water harvesting Pond.

3.20.00 **Chain Link Fencing**

Chain Link fencing shall be as per Cl. No.:4.00.00.19

3.21.00 **Temporary Fencing**

The construction of Temporary Fencing shall be done as mentioned below:

- a) 50NB G.I. post and its foundation shall be at 3.0m interval.
- b) Fence shall be installed along lines shown on approved drawings.
- c) Total height of the posts shall be 2400mm from grade level.
- d) Strainer posts shall be provided at sharp changes in grade, at comers at change of direction and where directed, and at every 30.0m interval.
- e) All comer post will have two stay posts and every tenth post will have a transverse stay post.
- f) Barbed wires shall run post to post and to be fixed to the posts by tightening hooks.
- g) Diagonals and vertical per span with barbed wire shall be provided. In general CPWD specification is to be followed.

3.22.00 **Sanitary Drainage System**

- a) Diameter of Soil Pipe and Waster Pipe outside the building and vertical / horizontal stack connected with sanitary fixtures shall not be less than 150 mm for rain water and for sewage 110mm OD pipes.

- b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995)

Pipes shall be as follows:

DI Pipes --- Plant Buildings

UPVC Pipes ---- Non-plant Buildings

DI Pipes --- Underground Pipes

For sewage line, UPVC pipes above ground and DI pipes below Ground shall be used (DI pipes for less than 200mm dia. and RCC NP3 hume pipes for dia 200mm and more).

- c) IS: 1742 - Code of Practice for building drainage & IS: 5329-Code of Practice for sanitary pipe work above ground for buildings shall be followed.

- d) If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

- 1). 100 mm nominal dia. : 1 in 57
- 2). 150 mm nominal dia. : 1 in 100
- 3). 200 mm nominal dia. : 1 in 145
- 4). 250 mm nominal dia. : 1 in 195
- 5). 300 mm nominal dia. : 1 in 200

- e) Each floor drain shall have 'P' or 'S' trap connection as required.

- f) Pipe to pipe shall be connected in 45° or 135° both vertically and horizontally.

- g) For cleaning purpose during maintenance, Floor Cleanout and Wall Cleanout shall be provided for horizontal run and vertical run of the pipes.

- h) In no case soil pipe shall be connected to waste pipe.

- i) In vertical stack proper venting system with anti-siphonage vent pipes shall be provided for all Water Closets.

- j) Drop slab of minimum 450mm depth shall be provided for the toilets where technically and aesthetically required.

- k) All plumbing and water supply fittings & fixtures, rain water drainage of plants of any building/premises/open area are in the scope of this contract. All the sewerage shall be collected from these area and the same shall be interconnected to the Main Plant Sewer System) at the RCC man hole as per detailed layout requirement.

4.00.00

DESIGN DATA FOR ARCHITECTURAL WORKS

- 1) Brick works –
Internal and external : 230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All non-load bearing Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise. Chamber burnt clay bricks shall be used in case of non-availability of Fly ash bricks, subject to the approval of NLCIL.
- 2) Half brick thick wall: 1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.
- 3). Damp proof course: 40mm thick 1:1.5:3 Concrete with 12mm BG metal and a 2% admixture of water proofing compound or as per manufacturer's recommendation.
- 4). Plaster:
Exterior & rough side: 20 mm thick with 1:4 cement- sand of interior brick wall mortar in two layers except where special finish provided.

Interior: 12 mm thick with 1:4 cement- sand mortar

Ceiling: 10 mm thick with 1:3 cement- sand mortar. (chicken wire mesh shall be provided at the junctions between RCC-BW , Steel-BW, etc. before applying Plastering)Also refer CI 2.02.03/Sec Iv/Part B/G2 of Vol II)
- 5). White Cement
Putty Punning: 3 mm thick punning to be provided to all areas receiving acrylic emulsion paint.
- 6). Metal Cladding :

The wall cladding for buildings shall be of single skin or double skin sandwiched/insulated wherever specified. The double skin sandwiched prefabricated factory made Rockwool/PUF TR panels comprising of outer metal colour coated profile steel sheet of minimum depth 34.5 mm at 333 mm pitch & inner slightly ribbed or plain permanently colour coated steel sheet made out of 0.6 mm TCT high tensile zinalume steel (150 gsm. Zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for top sheet and 0.5 mm TCT zinalume steel (150 gsm zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for inner sheet. The sheet shall have colour coating with

silicon modified polyester finish of thickness 20 microns over 5 microns (DFT) back coat for outer surface and 5 microns over 5 microns (DFT) back coat for inner surface of the sheet. The permanently colour coated sheet shall meet the general requirements of IS:513, IS:277 & IS:14246. In between the metal sheet, there will be **Prefabricated Rock wool insulation** having density 100 kg/m³ and average thickness 50 mm conforming to IS:8183 having a thermal conductivity value of 0.040 W/m²K at 50°C mean temp. Alternatively insulation shall be PUF having density of 40- 42Kg/m³ and a thermal conductivity value shall be as per IS:12436. The prefabricated Rockwool/PUF panels shall be supplied up to max. length of 12 m and finished with profile sheet overlap jointing arrangement. The panels shall be directly bolted on to the horizontal runners. The double skin cladding with single skin on either side of the horizontal runners without insulation wool in the middle shall also be used as per the requirement and as specified

Note: : For single skin wall cladding/ roofing, specification for sheet as mentioned above is to be followed and the thickness of the sheet shall be 0.8mm minimum for roof sheeting and 0.6mm minimum for side cladding. Flashings shall be of same material that of sheeting.

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer

Metal Deck Sheets for RCC roofs/Floors

All the buildings/Structures having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS: 14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated on exposed surfaces, galvanised M.S. troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm or as per the design requirement whichever is higher and minimum trough depth of 38 mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq. m. Dry film thickness of colour coating shall be at least 20 micron.

8). False Ceiling :

Aluminium pre-painted stove enamelled finish false ceiling, either lineal panel system or aluminium tile/plank system.

a) Panels

Panels to be manufactured from pre-painted, stove enamelled, alloy EN-AW-5050 or equivalent (according to EN 1396 and ECCA).

Panels are to be coupled in longitudinal direction by means of panel splices.

Optionally the flange with 3 x 7 ventilation holes can be used to achieve a ventilated ceiling.

b) Suspension

Rows of 0.5 Fe/0.95 Aluminium roll formed carriers shall be installed about 1200mm center on center by means of adjustable suspensions about a distance of 1200mm, center on center. Carriers will be joined by means of carrier splices. Carriers provided with prongs to hold panels in a standard module of 100 mm.

c) Perimeter Profiles

- Clip-on U-profile, 28.6x12.5 x20 mm, made of 0.35 thick aluminium
- Wall L-profile, 29.2x19.4 mm, made of 0.5 mm thick aluminium
- Wall L-profile, 45x18.5 mm, made of 0.8 mm thick aluminium
- Wall W-profile, 45x21x21x18.5 mm, made of 0.8 mm thick aluminium

d) Perforations

Manufacturer shall supply panels with following perforation specifications:

- \varnothing 1.0 mm, Δ 2 mm with 23% open area
- \varnothing 2.0 mm, Δ 5 mm with 16% open area

Perforated panels to have a nominal plain border along the longitudinal panel direction to assure a maximum flatness and product stability:

- 84C panel, 1 mm perforated to have a plain border of 7 mm
- 84C panel, 2 mm perforated to have a plain border of 6 mm

e) Acoustics

Manufacturer shall supply acoustic non-woven tissue, thickness 0.2 mm factory applied inside the panels.

Alternatively the installer can place individual PE wrapped mineral wool pads.

f) Coating

The coating will consist of a tough and durable polyester finish in nominal thickness of 20 microns, applied in a continuous coil-coating process ensuring uniform coating and absolute adhesion.

g) Installation

All materials shall be installed by the approved applicator/erector of the manufacturer under supervision of the authorized representative of the manufacturer.

9). Floor finish:

- a) Generally finish to utility areas shall be 50 mm thick heavy-duty granolithic flooring with metallic hardener on concrete slab. The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B & C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile strength of concrete in terms of its adhesive bond strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of the layer to be done with non-degrading membrane forming curing & sealing compound shall be acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m² in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

- b) For T.G.Hall (operating floor) Granite stone flooring finish will be as follows:

Minimum 18 mm thick polished Granite stone slab of size minimum 0.9 x 2.0 m to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall

be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

- c) For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 50 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Chemical resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Chemical resistant paint.

For battery room finished with Epoxy flooring (where required)

On the prepared substrate, one coat of a solvent free, resin based dispersion Primer shall be applied. Density of the primer is around 1kg/ltr and the mixing ratio of two components, Comp. A and B:: 1:2.5 by weight.

Over the primed surface, epoxy modified cementitious self levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three components Comp. A: Comp. B:Comp.C: 1:2.5:17 by weight, compressive strength at 30°C approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/ltr.

Priming shall be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A comp.B:3:1(by weight).The mixed density is 1.5kg/ltr. at 27°C. The system shall be allowed for curing for 3 days.

- d) All areas of toilet, including W.C and urinals have anti-skid vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness upto 100 mm higher than lintel level

starting from finish floor level.

- e) Floor/ staircase and the areas prone to slippage due to oil spillage etc. shall be provided with non-skid floor finish.
 - f) 1000 mm wide, minimum, P.C.C. paving as plinth protection, shall be provided around all buildings with surface drain of required size.
 - g) Risers and treads of concrete staircase of powerhouse and service building shall be of Granite slab and in all other RCC stairs of other plant buildings; same shall be of Kota stone finish with 20/25 mm .All areas shall have 150 mm high skirting unless indicated otherwise in the specification.
 - h) For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of minimum 1.0m width shall be applied in front of electrical equipment as per statutory norms.
- 10). Doors and Windows:

- a) Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.

Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames shall be mitered and field assembled with self tabs. Frames shall be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed shall be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door shall be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges shall be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass shall be 5 mm

clear toughened glass. Louvers when recommended shall be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

- b) Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel conforming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates shall be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied shall be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision shall be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers shall be provided on the striking jamb. Frames shall be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed shall be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge) minimum thick galvanised steel sheet. The internal construction of the door shall be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges shall be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable shall be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass shall be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

- c) Main Entrance of Control Room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing with sensor operated sliding type doors with all necessary hardware.
- d) For main entrance of service building, and control equipment room, offices and where technically required double swing type full glazed minimum 3mm thick aluminium i.e. coloured powder coated aluminium door. Full glazed aluminium partition with airlock shall be provided along (B) row of Turbine hall operating floor where clear view is desired. Glazing between air-conditioned areas shall be single glass whereas that between air- conditioned and non-air- conditioned area shall be with hermetically sealed insulating glass.
- e) Doors of W.C and shower shall be hard core FRP door.
- f) Full glazed windows and ventilators shall be powder coated and UV protected aluminium window frame with 6 mm thick (depending on the size of panel) clear float glass and 5.5 mm thick clear wired glass where required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators. Glazing between AC and Non AC areas shall be double insulated glass. Aluminium sections shall be of heavy duty and from reputed and approved manufacturer. Windows and ventilators shall be fabricated and painted by the reputed fabricators at their own fabrication shop. Windows shall be glazed aluminium windows conforming to IS: 1949 & IS: 1948.

11). Rolling Shutters:

Rolling shutters as per IS: 6248 with electrically operating arrangement according to size shall be provided in buildings to facilitate handling and transportation of equipment for large openings from 9.0 sqm and above. Wherever truck entry is envisaged, minimum size of rolling shutter size shall not be less than 3.5m (W) x 4.0m (H). For any additional details refer Vol-II/G2/Part-B.

12). Glazing:

- a) Glazing for windows in general shall be minimum 6 mm clear float glass and as mentioned elsewhere in this document.

- b) Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.
 - c) Minimum 8.0 mm thick toughened float glass as specified below shall be provided in doors, partitions, of Power house building, Service Building, , etc.
 - d) 24 mm thick insulated double glazing having 6 mm thick tinted heat- reflecting type outer float glass and 6 mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on powder coated aluminium frame suitable for structural glazing system.
- 13). Roof waterproofing :
- a) Roof waterproofing treatment shall be as follows:

For roofs with structural slope:

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer 10% by weight of cement. Top of thoroughly cleaned roof surface shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with $\geq 500\%$ elongation conforming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M 15 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with pressed clay tiles of size 230x230x18 mm laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar in 1:3 proportion. A latex based bonding agent shall be added (10% by weight of cement) and also a glass cloth must

be inserted around the junctions while the angle fillet is being constructed.

For roofs having no structural slope:

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer 10% by weight to cement. Top of thoroughly cleaned roof surface shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with $\geq 500\%$ elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 35 mm average thick (thickness will depend upon the required slope and span of the building) M 15 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3m x 4m) with grooves 10mm x 10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with pressed clay tiles of size 230x230x18 mm laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar in 1:3 proportion. A latex based bonding agent shall be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For vertical surfaces (Parapet)

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls (2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: Waterproofing materials shall be applied by the manufacturer in house application wing or authorised applicators only under supervision of manufacturer's authorised person.

- b) For efficient disposal of rainwater, the runoff gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.
 - c) Heavy duty UPVC pipes of 150mm dia minimum conforming to relevant BIS Code shall be provided to drain off rainwater from the roof for Non plant buildings. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527. For plant buildings DI pipes of 150mm dia. shall be provided.
- 14). Painting:
- a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint 2 coats (over a coat of primer) over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.
 - b) Acrylic plastic emulsion paint of reputed make, 2 coats over a coat of primer approved by owner shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.
 - c) All other areas shall also be provided with Acrylic Emulsion paint 2 coats over a coat of primer.
 - d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade 2 coats over a coat of primer up to a height of 1.5 m above floor level.
 - e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with chemical resistant paint. Chemical resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Chemical resistant paint.
 - h) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti-corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant,

Coating skin tensile strength 18 to 21 kg. Per sq. Cm.
Antifungal, antibacterial, anticorrosive, nontoxic graft Co-
polymer coating as specified elsewhere.

- i) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.
- j) All fire exit doors shall be painted in Post Office red 2 coats over a coat of primer.
- k) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.
- l) Fire-proof putty for cable penetration openings on walls of cable spreader rooms is to be provided for fire sealing
- m) In general unless otherwise specified, Two coats of paint shall be applied over a coat of primer paint as per manufacturer's recommendation.
- n) Internal Acrylic Emulsion Paint 2 coats over a coat of primer are to be applied over 3mm thick white cement putty finish.

15). Aluminium Composite Panels

a) Material:

Total thickness of the panel–4mm. Thickness of the aluminium skin– 0.5mm, Tensile strength of aluminium skin–120N/mm² minimum, Density of PEcore–920–980Kg/m³(Non toxic grade Polyethylene) Coating –PVDF Adhesive film–DUPONT,USA Coating thickness(front foil)– 24µ-30µin PVDF including primer.15µ-18µin polyester coating. Coating thickness (back foil)– 4µ-7µ polyester coating.

- b). Colour–as indicated in the drawing.
- c). Fixing arrangement–aluminium composite sheets shall be folded inwardly on four edges(without cutting the outer skin) to form Aluminium Composite Panels(ACP)and shall be riveted to the aluminium extruded section like angle or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be 200 mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant

of approved make (GE or similar make) to prevent water seepage.

- d). The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The **Contractor** shall take site measurement and produce working drawings for approval of engineer before erection of ACP.

16). **Polycarbonate Sheet:**

- a) 4 mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or MAKROLON Polycarbonate sheet or similar approved.
- b) Framing shall be specially designed aluminium sections, colour anodised, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.
- c) Sealing of joints shall be done with Silicon sealant.
- d) Minimum Density required for Multiwall Polycarbonate and Compact sheets:-
- 6 mm Multiwall Sheets: - 1.3 kg/m²
 - 8 mm Multiwall Sheets: - 1.5 kg/m²
 - 10 mm Multiwall Sheets: - 1.7 kg/m²
 - 16 mm Multiwall Sheets:- 2.8 kg/ m²
 - Compact Sheets: - 1.2 kg/m²/mm
- e) The sheets shall have the minimum co-extruded UV coating of min 45 Micron
- f) The fixing shall be done Aluminium Clamping profile (top and bottom) min 60mm wide profile with EPDM gasket by using self-driving and self-tapping screws.
- g) The sheet should be produced and supplied Preferably by local manufacturer
- h) The sheet shall pass the ISI 14443 specification for Multiwall system.

17). **Stairs:**

- a) All stairs shall have not more than 12 risers in one flight. All staircases shall comply with all staircase related norms of National Building Code 2016, Part-4.

Height of risers and width of treads shall be 150 mm

(maximum) and 275 mm (minimum) respectively for fire escape stairs and 150 mm (maximum) & 275mm (minimum) for general staircases (for both RCC and Steel). Minimum width of stairs (for both steel and RCC) shall be 1500mm for indoor stairs and 1200mm for outdoor stairs (Unless specified otherwise). In general preferred rises shall be 150 mm high. For public buildings, the riser shall not exceed 150 mm height. The above is for all the buildings/structures under civil scope only.

- b) Aluminium angle nosing shall be provided for edge protection of RCC stairs. Moulded granite nosing shall be provided for the main stairs finished with granite slab/ kota slab finishes.
- c) 40Ø NB stainless steel pipe handrail for stair in Service Building & T.G. Hall area and 40ØNB medium class G.I pipe Handrail & vertical post and 40Ø NB medium class G.I horizontal mid rails for stairs in other areas is to be provided. Minimum 1.0 m high hand railing, shall be provided around all floor / roof openings, projections / balconies, walkways platforms, concrete and steel stairs. 1200 mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000 mm / 1200 mm (for higher elevation) above the walkway/ platform/ floor surface and the intermediate rail 500 mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500 mm c/c to posts. Stainless steel class shall be 304 grades. 150 mm high toe guard is to be provided.

18). Draining out water from floors

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc., shall be provided in each floor.

19). Fencing :

Minimum 3.00 meter high chain link fencing above toe wall shall be provided around building transformer area & other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 3.00 metre high galvanized chain link fencing of minimum 3.15 mm diameter G.I. wire of mesh size 75 mm. The diameter of steel line wire for chain link fencing shall not be less than 4.0 mm. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level. Chain-link fencing shall be as per IS: 2721. Galvanisation on chain link shall be as per IS: 12753, hard coated finish. Vertical posts shall be 80NB G.I. pipe as per IS: 1161 (medium class) at 2.5m interval and with strainer posts wherever necessary.

20). Water Supply and Sanitation:

- a) 1 no. Potable roof water tank and 1 no service water tank (HDPE white colour) of adequate capacity (minimum 1000 litres capacity each) depending on the number of users shall be provided for all the buildings except Power house where it is of RCC (internally lined with glazed ceramic tiles).
- b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type
- c) Extra heavy DI pipes or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.
- d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.
- e) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995)

Pipes shall be as follows:

DI Pipes --- Plant Buildings

UPVC Pipes ---- Non-plant Buildings

DI Pipes --- Underground Pipes

- f) Each toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided in each floor as specified elsewhere.

Minimum fixtures in each toilet shall be as follows.

- All the facilities such as WC, Urinals, wash basins etc. shall be based on occupant load as per NBC and shall be of approved colour. However minimum requirements are given below.
- WC (Indian type) (minimum 580x440mm) as per IS: 2556 (Part-3) with all fittings including health faucet, flushing arrangement of appropriate capacity and type – 1 no.
- WC western type as per IS: 2556 (part 2) with toilet paper roll holder and health faucet and all fittings including flushing system of appropriate capacity and type – 1 no.

- Urinal with sensor operated (IWC for ladies toilets) with all fittings including partition with photovoltaic control flushing system as per IS: 2556 (Part-6, Sec.1) – 2 nos.
- Wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with min. 18 mm thick polished granite stone – 2 nos.
- Stainless steel towel rail (600 x 20mm) - 2 nos.
- Stainless steel liquid soap holder cum dispenser – 2 nos.
- Janitor room.
- Provision for ventilation shaft.
- Ladies toilet will be provided with items as in Gents Toilet except urinals.
- Sink–Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas of approved make.
- Metal storage cabinets, under- counter as well as over head, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
- Minimum 600mm long Chromium plated tray.
- Chromium plated toilet paper roll holder
- Recessed Chromium plated soap tray in shower area.
- Robe hooks
- Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc. shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval. However minimum 1 EWC and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, minimum 2 urinals shall be provided in each Gents toilet and all above fixtures without urinals for ladies toilet.

Note Toilets in Power House Operating Floor, Operating

floor of service shall have coloured fixtures including counter-top wash basins with wide mirror, European type water closet with flush valve, sensor operated urinal, exclusive shower set etc. Other toilets in general shall have fixtures, low down cisterns, sensor operated urinals etc. Toilets for handicapped persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures (minimum one EWC, Wash basin and mirror).

21). Under-Deck Insulation

- a) Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- b) Density of Material shall be between 40 to 60 Kg/m³
- c) Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m²K at an average temperature of 0°C
- d) The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category. Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value shall be minimum 7000.
- e) Under-deck insulation shall be provided for all AC areas having roof exposed to sun/floor exposed to heat atmosphere.
- f) Thickness:
 - For Concrete Slab: 50 mm thick sheet is used
 - For Corrugated or metal ceiling: 50 mm thick sheet

22). Sealant:

- a) Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation having weathering resistance to ultraviolet ray property. The product shall exhibit shore 'A' hardness of 25 and have movement accommodation factor of 25%. The sealant must comply with the performance specifications as laid in BS:4254 and ASTM C 920. All the joints must be primed using compatible primer for the substrate from the. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.
- b) Polyurethane based single component joint sealant materials based upon polyurethane resins shall be. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm²

and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600 % and recovery of 80%.

23). Expansion joints may be as per following locations:

- a) Floor to Floor Joints at all internal locations
- b) Roof to Roof Joints
- c) Floor to Wall joints at internal locations
- d) Roof to Wall Joints
- e) Wall to Wall joints in exterior locations

During construction of RCC slab, beam, column the expansion gap shall be maintained by using polystyrene filler board.

During finishing stage expansion gaps shall be finished with the either elastomeric EPDM profile or elastomeric extruded poly vinyl chloride fitted in extruded aluminium sections with aluminium joint cover to form an integral system as manufactured by Three R Construction solutions Pvt Ltd. or an approved equivalent.

Expansion gap between metal cladding shall be finished with metal of same material having 'U' or 'W' shape and shall be covered with metal cladding –fixed at one end and fixed with slotted hole on other end or as per manufacturer's detail.

Externally the expansion joint sealing system shall form a continuum vertical and horizontal sealing system to make the building envelop water tight.

24). Statutory rules :

- a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State,

Rules of Tariff Advisory Committee (TAC), and Water Act for pollution control etc.

- b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 600 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, restrooms etc.
- c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. shall be made according to the recommendation of Loss Prevention Association of India /Tariff Advisory Committee.



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- d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.



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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Turbine and its related Auxiliaries							
Turbine Building							
1	T.G. Hall Area,	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite stone slab. Unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite stone finished walkways.	Acrylic emulsion paint over white cement putty on masonry surfaces wherever necessary and all other wall surface shall be with Acrylic Emulsion, Polished Granite slab minimum 18 mm thick wall cladding on (B) row wall (outer) upto false ceiling level/upto Roof slab of Control Room facade. There shall be minimum joints between granite slabs. The quality including colour texture etc. of granite shall be approved by the owner. The façade of control room may also be finished with ACP	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic emulsion on exposed plastered ceiling (without false ceiling). Aluminium lineal pattern false ceiling / Aluminium plan or tiles type in combination with Gypsum board/ Acoustical type board shall be used for false ceiling areas.	Hollow metal flush door in general and 2Hr Fire Check door for fire escape stairs and electrical rooms. Important areas shall have Glazed aluminium door. For main entrance to Main control room shall be sensor operated glazed sliding door.	Aluminium glazed window. Main glazed partition for Main control room shall be insulated double glazed as per specification. A Row shall have structural glazing with low E glass blue tinted toughened glass on outer face and clear toughened float low E glass on inner face as per specification.	All painting works are 2 coats over a coat of primer.

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
			cladding / Exterior type wooden panels or any other latest state of the art façade treatment material as approved by the Owner. Above false ceiling of control room & Annexure room there shall be exposed plastered masonry surfaces. A row and gable end shall have double skin metal cladding system.				
2	Switchgear Room, MCC Room & Battery charger Room,	1.0m wide Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid in front of equipment over heavy duty vitrified tiles flooring or PU flooring. Overall thickness shall be 50mm.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	All painting works are 2 coats over a coat of primer
3	Control Rooms, Control Equipment Room, UPS room ,Computer	Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles of minimum size minimum 600	Fly Ash Brick masonry walls, columns, or any other element within the room as the case may be, shall be clad	Lineal pre-coated aluminium alloy ceiling stove enamelled on both sides similar to 'Luxalon' with Gypsum	Aluminium glazed door	-Do-	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Rooms, etc. Other than Main Control Room.	mm x 600 mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles and under bed.	with polyester coated 4mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.50 mm) of approved make up to the false ceiling level. The colour and design composition of ACP cladding to be submitted for approval of the authority before erection.	board to form pattern including suspension system as per manufacturer's details. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be Closed Cell Elastomeric Nitrile Rubber.			
4	Main Control Room	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
5	All office areas, Conference Room and other important areas in connection with main control room.	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm" (overall 50 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic mineral fibre board ceiling on aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling.	Aluminium glazed door single or double leaf with 8mm thick toughened, tinted & etched float quality glass as per owner's choice with floor spring, mortise lock & latch and all accessories.	Aluminium glazed window with minimum 6mm thick clear float glass of specific values as mentioned in the specification with all accessories. Windows shall be partially open able and partially closed type having shutter size not more than 750Wx1500H mm.	All painting works are 2 coats over a coat of primer
6	Main Stair & Landing	Granite slab 18 mm thick (min.) with larger possible size to be approved by the owner.	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty.	Aluminium glazed door/ fire door	-Do-	All painting works are 2 coats over a coat of primer

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
7	Lift lobby	Granite slab 18 mm thick (min.) with larger possible size to be approved by the owner.	Granite slab(12mm) cladding	Aluminium lineal pattern false ceiling	Aluminium glazed door/ fire door	-Do-	
8	Battery Room	Acid/Alkali resistant vitrified tiles flooring along with 2100 mm high dado of same material.	Chemical resistant paint.	Chemical resistant paint.	Hollow metal flush fire door	-Do-	All painting works are 2 coats over a coat of primer
9	Chemical Feed Station	Acid/Alkali resistant vitrified tiles flooring along with 2100 mm high dado of same material.	Chemical resistant paint.	Chemical resistant paint.	Hollow metal flush fire door with chemical resistant paint finish	-Do-	All painting works are 2 coats over a coat of primer
10	AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Acrylic emulsion Paint	Acrylic emulsion Paint	Hollow metal flush fire door. For AHU Room and Air Washer rooms airtight doors are to be provided.	-Do-	All painting works are 2 coats over a coat of primer
11	Toilet and other wet areas	Minimum 10 mm thick non-skid vitrified tile minimum size 400 mm x 400 mm (overall 50 mm thick) with	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100	Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required.	Main entry to toilet or wet areas shall be wooden	Aluminium glazed window/ ventilator	All painting works are 2 coats over a coat of primer

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be 100 mm higher than lintel level starting from finish floor level.	mm higher than lintel level starting from finished floor level. Acrylic emulsion paint over white cement putty above dado.		panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.		Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in operating /ground floor
12	Oil Spillage area	Non-skid self-levelling epoxy over IPS (overall 50 mm thick)	Epoxy paint.	Epoxy paint.	Hollow metal flush door / fire door	-Do-	All painting works are 2 coats over a coat of primer
13	Electrical Switchgear Room, MCC Room, etc.	1.0m wide Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid in front of equipment over heavy duty vitrified tiles flooring or PU flooring. Overall thickness shall be 50mm.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	All painting works are 2 coats over a coat of primer
14	All other general areas except operating floor	Overall 50 mm thick heavy-duty concrete Granolithic floor with metallic hardener.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	All painting works are 2 coats over a coat of primer

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
CPU Regeneration Building							
1	CPU Regeneration Area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint with cement putty up to 1.50mts height and Acrylic Emulsion for balance height	Acrylic Emulsion	Hollow metal flush door / fire door. For AHU Room and Air Washer rooms airtight doors are to be provided	Aluminium glazed window / ventilator	All painting works are 2 coats over a coat of primer
2	Cable Spreader Room	Overall 50 mm thick heavy-duty concrete Granolithic floor with metallic hardener.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	All painting works are 2 coats over a coat of primer
3	Control Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm" (overall 50 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic mineral fibre board ceiling on aluminium grid system.	Aluminium glazed door single or double leaf	Aluminium glazed window	All painting works are 2 coats over a coat of primer
4	Electrical Room	Overall 50 mm thick heavy-duty concrete Granolithic floor with metallic hardener.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	All painting works are 2 coats over a coat of primer

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
5	PAC Room	Overall 50 mm thick heavy-duty concrete Granolithic floor with metallic hardener.	Acrylic Emulsion	Acrylic Emulsion	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	
6	Toilet	Minimum 10 mm thick non-skid vitrified tile minimum size 400 mm x 400 mm (overall 50 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be 100 mm higher than lintel level starting from finish floor level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finished floor level. Acrylic Emulsion paint over white cement putty above dado.	Acrylic Emulsion paint over white cement putty. Aluminium false ceiling where required.	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	Aluminium glazed window/ ventilator	Toilets for Gents , ladies
7	Staircase	Kota stone slab	Acrylic Emulsion	Acrylic Emulsion	Fire door	Aluminium glazed window / ventilator	All painting works are 2 coats over a coat of primer
CST Pump Shed							
	General area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Open	Exposed painted steel structure			All painting works are 2 coats over a coat of primer
ACW pump house							
1	ACW Pump	50 mm thick heavy duty	Synthetic enamel paint	Acrylic Emulsion	Hollow metal	Aluminium	All painting

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Room	cement concrete Granolithic floor with metallic hardener and matching skirting	with cement putty up to 1.50mts height and Acrylic Emulsion for balance height		flush door / fire door	glazed window / ventilator	works are 2 coats over a coat of primer
2	Air Washer Room	50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener and matching skirting	Synthetic enamel paint with cement putty up to 1.50mts height and Acrylic Emulsion for balance height	Acrylic Emulsion	. Air Washer rooms airtight doors are to be provided	Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided ,
DG Shed							
	General area	50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener and matching skirting	Open	Exposed painted steel structure			All painting works are 2 coats over a coat of primer
Plant IA/SA Compressor House							
	General area	50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener and matching skirting	Acrylic Emulsion paint	Acrylic Emulsion paint	Hollow metal flush door with louver.	Aluminium glazed window / ventilator	All painting works are 2 coats over a coat of primer Toilets for Gents and

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
							ladies shall be provided ,
A/C plant building and Inert gas room							
		50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener and matching skirting	Acrylic Emulsion paint	-	Hollow metal flush door painted with Synthetic enamel paint, both ways.	All round fly ash brick wall with RCC jally.	
Boiler and its related Auxiliaries							
Mill &Bunker Building							
		50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.00mts height wall and double skin metal cladding for balance height.	Exposed painted structure.	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	Polycarbonate sheet shall be combined with metal cladding to form pattern. Toilets for Gents and ladies shall be provided ,
Boiler Maintenance Building							

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	MCC Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern. MCC rooms shall have flexible electric insulated PVC synthetic sheet in front of MCC Panels.	Acrylic Emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door	Aluminium window / ventilator	
	Electrical & Mechanical Store Rooms	50mm thick heavy duty granolithic flooring with metallic hardener. Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty for balance height.	Exposed painted structure	Hollow metal flush door	Aluminium window / ventilator	
	Office	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.	Acrylic emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush door	Aluminium glazed window / ventilator	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of make of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And	Pre-coated aluminium panelled (600mmx600mm size) ceiling	Main entry to toilet or wet areas shall be wooden panel door in hard	Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided ,

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	balance portion with Acrylic Emulsion paint over white cement putty.		wood frame and doors for WCs shall be FRP door frame & shutter.		
	Maintenance Bay	50mm thick heavy duty granolithic flooring with metallic hardener.	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty for balance height.	Exposed painted structure.	Hollow metal flush door & Rolling shutter.	Aluminium glazed window / ventilator	
ESP Control Building							
	Control room, Control panel room, Control equipment room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern for Control room.	Acrylic emulsion paint over white cement putty for control room	Pre-coated aluminium panelled (600mmx600mm size) ceiling similar to 'Luxalon" in Control room and air-conditioned areas.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	
	Switchgear room, Cable spreader room, other electrical	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty for	Acrylic Emulsion paint	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	rooms	sheet in front of electrical equipment.	balance height.				
	MCC Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern. MCC rooms shall have 1.0m wide flexible electric insulated PVC synthetic sheet in front of MCC Panels.	Acrylic Emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of make of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in operating /ground floor

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Staircase & Lobby	Overall 50mm thick granite slab flooring with 18 mm thick granite slab and matching skirting	Acrylic Emulsion Paint over white cement putty	Acrylic Emulsion Paint	Fire check doors -2hr rated.	Aluminium glazed window / ventilator	SS railing for stairs.
Fuel Oil Unloading cum Pressurising Pump House							
		Self-levelling PU/epoxy floor on oily areas and heavy duty Granolithic flooring with hardener in balance areas.	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint with white cement putty for balance height	Acrylic Emulsion paint	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	
Auxiliary Boiler MCC & Control Room							
	Control Room and office area	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.	Acrylic emulsion paint over white cement putty .	Pre-coated alu. linear ceiling similar to 'Luxalon in air-conditioned areas. Exposed painted structure in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium glazed window / ventilator	
	Switchgear room, Cable spreader room, other electrical rooms	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty for balance height.	Acrylic Emulsion paint	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	MCC Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern. MCC rooms shall have 1.0m wide flexible electric insulated PVC synthetic sheet in front of MCC Panels.	Acrylic Emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	
	Other areas	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty	Acrylic Emulsion paint	Hollow metal flush door	Aluminium glazed window / ventilator	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of make of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be	Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in operating /ground floor

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		lintel level starting from floor finish level.			FRP door frame & shutter.		
Compressor Shed in Ammonia Storage Area							
		Alkali acid resistant tiles over 50 mm thick heavy duty cement concrete floor and matching skirting	Open.	sheet roof			
MCC / Operator Room for SCR System							
	MCC Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern. MCC rooms shall have flexible electric insulated PVC synthetic sheet in front of MCC Panels.	Acrylic Emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door	Aluminium window ventilator /	Toilets for Gents and ladies shall be provided
RIO-cum-VFD Panel Room							
	R I/O room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.	Acrylic emulsion paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door	Aluminium window ventilator /	Toilets for Gents and ladies shall be provided

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Coal Handling System and its related Auxiliaries							
1	Receiving Tower	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Single skin sheet metal cladding in combination with polycarbonate sheets	Painted exposed structure-Synthetic enamel on steel and Acrylic Emulsion on RCC	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	
2	Drive House	50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener	Single skin, Zinalume metal cladding in combination with polycarbonate sheets. Acrylic emulsion paint on fly ash brick wall.	Painted exposed structure-Synthetic enamel on steel and Acrylic Emulsion on RCC	Hollow metal flush door painted with Synthetic enamel paint, both ways.	Powder coated and UV protected Aluminium glazed window / ventilator	
3	Crusher House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Double skin sheet metal cladding in combination with polycarbonate sheets. Acrylic emulsion paint on 3m high fly ash	Painted exposed structure-Synthetic enamel on steel and Acrylic Emulsion on RCC	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided in Ground floor

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
			brick wall.				
4	Junction towers	-Do-	Single skin sheet metal cladding in combination with polycarbonate sheets and Acrylic emulsion paint on fly ash brick wall.	-Do-	-Do-	-Do-	
5	Conveyor gallery	-Grade slab shall be finished with 50mm concrete with metallic hardener.	Single skin sheet metal cladding in combination with polycarbonate sheets.	Synthetic enamel Painted on Steel	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	
6	CHP Control room cum switchgear building						
	Control Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door and at the Main entrances collapsible	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
					door shall also be provided		
	Electrical Room & switchgear room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting 1.0m wide flexible electric insulated PVC synthetic sheet is to be laid in front of electrical equipment.	White cement wall putty for full height Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion Paint.	Hollow metal flush door / fire door	-Do-	
	Battery Room	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel	Acrylic Emulsion paint.	Main entry to toilet or wet areas shall be wooden	-Do-	Toilets for Gents and ladies shall be provided in all floors , Along

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.		panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.		with toilet for Physically challenged in ground floor
7	Pump cum compressor houses for DDS/ DFDS	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion paint.	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents shall be provided
8	Coal Handling system maintenance Building	50mm thick heavy duty granolithic flooring with metallic hardener.	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty for balance height.	Exposed painted structure.	Hollow metal flush door & Rolling shutter.	Aluminium glazed window / ventilator	
Ash Handling System and its related Auxiliaries							
1	Ash water pump house						

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Pump house	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion paint	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents shall be provided
	Control room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door.	-Do-	Toilets for Gents and ladies shall be provided.
2	Silo utility building cum HCSD pump house						
	General area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Control room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting.	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door.	-Do-	
	Battery room	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs	-Do-	Toilets for Gents and ladies shall be provided.

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		lintel level starting from floor finish level.	cement putty.		shall be FRP door frame & shutter.		
3	Compressor house and Main control room						
	Control room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	-Do-	
	MCC Switchgear rooms &	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting 1.0m wide flexible electric insulated PVC synthetic sheet is to be laid in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion paint	Hollow metal flush door / fire door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided in all floors, Along with toilet for Physically challenged at ground floor.
	Other area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion paint	Hollow metal flush door / fire door and at the Main entrances collapsible door shall also be provided.	Powder coated and UV protected Aluminium glazed window / ventilator	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
4	Ash water Transfer pump house						
	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	-Do-	Toilets for Gents shall be provided
Raw Water Transfer System							
1	Raw water Transfer pump house						
	Pump room and maintenance bay	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Control Room, Offices	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting.	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height for control room and Acrylic emulsion paint over white cement putty for offices for full height	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	
	MCC & Switch gear rooms	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame	-Do-	Toilets for Gents and ladies shall be provided .

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	Acrylic Emulsion paint over white cement putty.		and doors for WCs shall be FRP door frame & shutter.		
2	Intentionally Deleted						
Water Pre-treatment & DM Water System							
1	Chemical House with treatment Plant/ Lab						
	Offices	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting..	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door and at the Main entrances collapsible door shall also be provided	Powder coated and UV protected aluminium window Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	-Do-	-Do-	-Do-	
	Chemical store	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	
	MCC room, chlorine tonner room, & maintenance room	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	
	Toilet and wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be	-Do-	Toilets for Gents and ladies shall be provided in all

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.		wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.		floors , Along with toilet for Physically challenged in ground floor
2	PW Chlorination plant building						
	General area	Minimum 20 mm thick acid and alkali resistant vitrified tile or minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm	White cement wall putty. Chemical resistant paint in acid & alkali prone area and rest with Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Emulsion paint.	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		thick heavy duty flooring with metallic hardener.					
3	UF feed tank pump house						
	General area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Open. Acrylic Emulsion paint for bottom brick portion	Acrylic Emulsion paint	-	-	
4	DM plant building with switchgear room and control room						
	Plant area	Minimum 20 mm thick acid and alkali resistant Vitrified tile set in and jointed with epoxy mortar (overall 50mm thick)	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali prone area and rest with Acrylic Emulsion paint	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Emulsion paint	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Switchgear Room	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	
	Battery Room	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	
	Control Room & Offices	10 mm thick non-skid fully vitrified tiles of make of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	-Do-	-Do-	-Do-	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion Paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in ground floor

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
5	Clarified water pump houses						
	Pump room	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door and door At the Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	
	Control Room	10 mm thick non-skid fully vitrified tiles of make of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	-Do-	
	MCC & Switch gear rooms	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		sheet in front of electrical equipment.	for balance height			window ventilator /	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion Paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided.
	Battery Room	Minimum 20 mm thick acid and alkali resistant vitrified tile Minimum 37 mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Chemical resistant epoxy paint for balance height	Acid/Alkali resistant paint.	Hollow metal flush/ fire door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		having 20 mm thickness.					
6	Degassed water storage pump house	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents shall be provided
7	Pump house for Rain water harvesting	-Do-	-Do-	-Do-	-Do-	-Do-	Toilets for Gents shall be provided.
8	Switchgear/ MCC Room	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	-Do-	-Do-	-Do-	-Do-	Toilets for Gents and ladies shall be provided

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Effluent Treatment Plant							
1	E T P building including pump house and control room						
	General area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint with white cement putty for balance height	Acrylic Emulsion	Hollow metal flush door / fire door. Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	
	Control Room & Offices	10 mm thick non-skid fully vitrified tiles of make of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	-Do-	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from	Acrylic Emulsion Paint	Main entry to toilet or wet areas shall be wooden panel door	-Do-	Toilets for Gents and ladies shall be provided Along with toilet for

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height	finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.		in hard wood frame and doors for WCs shall be FRP door frame & shutter.		Physically challenged in ground floor
2	ETP CTBD/ RO building						
	General area	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door. Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Laboratories	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	-Do-	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion Paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided
3	ETP reject treatment plant building						
	General area	50 mm thick heavy duty cement concrete floor with	White cement wall putty. Synthetic	Acrylic Emulsion	Hollow metal flush	Powder coated and	Toilets for Gents shall be

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		metallic hardener and matching skirting	enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height		door / fire door. Main entrances collapsible door shall also be provided	UV protected Aluminium glazed window / ventilator	provided
Sewage Treatment Plant							
	STP Building						
	Control Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	
	MCC & Switch gear rooms and other areas	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height.	Acrylic Emulsion paint	Hollow metal flush/ fire door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		equipment.					
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents shall be provided
Circulating Water System							
1.	CW pump house with Switchgear room & RIO room						
	RIO room, Control Room, Offices	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting.	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height for control	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window /	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
			room and Acrylic emulsion paint over white cement putty for offices for full height			ventilator	
	MCC & Switch gear rooms	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door. Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	
	Pump room & Other areas	-Do-	-Do-	-Do-	-Do-	-Do-	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame	-Do-	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	Acrylic Emulsion paint over white cement putty.		and doors for WCs shall be FRP door frame & shutter.		ground floor
	Battery Room	Minimum 20 mm thick acid and alkali resistant vitrified tile Minimum 37 mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20 mm thickness.	20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and chemical resistant epoxy paint for balance height	Chemical resistant paint.	Hollow metal flush/ fire door	-Do-	
2.	CW Treatment cum Chlorination plant building						
	Control room & Offices	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height for control room and Acrylic	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door and at the Main entrances collapsible door shall	Powder coated and UV protected aluminium window Aluminium glazed	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
			emulsion paint over white cement putty for offices for full height		also be provided	window ventilator /	
	Chemical store	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	
	Battery room	-Do-	-Do-	-Do-	-Do-	-Do-	
	MCC room, chlorine tonner room, maintenance room and other areas	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door	-Do-	
	Toilet	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden	-Do-	Toilets for Gents and ladies shall be provided

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.		panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.		
Fire Protection & Detection System							
1	Fire Water PH	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door. Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents shall be provided
2	Fire Water Booster PH	-do-	do	do	do	Do	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Switchyard							
1.	Switch yard control building						
	Control Room, Offices	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height for control room and Acrylic emulsion paint over white cement putty for offices for full height	Stove-enamelled Aluminium false ceiling, similar or equal to LUXALON with either lineal panel system or aluminium tile/plank system with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator Windows of yard side shall be continuous to view the yard area.	
	MCC & Switch gear rooms & other areas	50mm thick heavy duty granolithic flooring with metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height.	Acrylic Emulsion paint	Hollow metal flush door	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided Along with toilet for Physically challenged in ground floor
	Battery Room	Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 50mm thick) along with 2100mm high dado of same tile.	Chemical resistant paint	Chemical resistant paint	Hollow metal flush door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
2.	GIS Building						
		2.2 mm Self Levelling Epoxy – Polyurethane System (EPU) over hardened concrete flooring	Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint over white cement putty	Acrylic Emulsion paint	Hollow metal flush/ fire door	-Do-	Toilets for Gents and ladies shall be provided
Hydrogen Generation Plant							
1	Hydrogen Generation Building	50 mm thick heavy duty cement concrete Granolithic floor with metallic hardener and matching skirting	Acrylic Emulsion paint	-	Hollow metal flush door painted with Synthetic enamel paint, both ways.	All round fly ash brick wall with RCC jally.	Toilets for Gents shall be provided
Flue Gas De-sulphurisation (FGD) Plant							
1	Limestone Storage Building`	50 mm thick heavy duty cement concrete granolithic floor with metallic hardener and matching skirting	Acrylic emulsion paint for wall and sheet metal cladding for balance height	Painted exposed structure	Hollow metal flush door / Rolling shutter	Powder coated and UV protected Aluminium glazed window /	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
						ventilator	
2	Limestone Crusher House	-Do-	-Do-	-Do-	-Do-	-Do-	Toilets for Gents and ladies shall be provided in Ground floor
3	Limestone Grinding Building	-Do-	-Do-	-Do-	-Do-	-Do-	
4	Absorber Pump & Oxidation air blower House	-Do-	Acrylic Emulsion paint with white cement putty for the full height	-Do-	-Do-	-Do-	Toilets for Gents shall be provided
5	Electrical Switchgear & Control Building						
	Control Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting	Acrylic emulsion paint over white cement putty.	Moisture & Fire Resistant Gypsum Board false ceiling with insulation on top.	Aluminium glazed door and at the Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	
	Electrical Room &	50mm thick heavy duty granolithic flooring with	Acrylic emulsion paint with white cement	Acrylic Emulsion Paint.	Hollow metal flush	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	switchgear room	metallic hardener. 1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	putty for the full height		door / fire door		
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Emulsion paint.	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be PVC door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged in ground floor
6	Gypsum De-watering House	50 mm thick heavy duty cement concrete granolithic floor with hardener and matching skirting	Acrylic emulsion paint for the full height and sheet metal cladding balance height	Painted exposed structure	Hollow metal flush door / Rolling shutter	-Do-	Toilets for Gents shall be provided
7	Gypsum Storage Building	-Do-	-Do-	-Do-	-Do-	-Do-	Toilets for Gents shall be provided

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
8	Junction towers	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Single skin sheet metal cladding in combination with polycarbonate sheets and Acrylic emulsion paint on fly ash brick wall.	Painted exposed structure-Synthetic enamel on steel and Acrylic Emulsion on RCC	Hollow metal flush door / fire door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents and ladies shall be provided in Ground floor
Non plant building							
1	Service Building	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	As mentioned in the specification	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
2	Canteen						
	Kitchen, Dining hall etc.	10 mm thick non-skid fully vitrified tiles" of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counters for Kitchen and service areas shall have Polished Granite slab over RCC slab.	1st quality coloured glazed tiles of minimum 5mm thickness up to 1.50m height and balance height with Acrylic emulsion paint over primer and white cement putty. Dado shall be full height for Kitchen.	Acrylic Emulsion paint over white cement putty. Air conditioned areas shall Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top of approved make as per specification	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	
	Other areas	Kota stone flooring and skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion paint	Solid core flush door	-Do-	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Toilet & wash areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided in all floors , Along with toilet for Physically challenged. in ground floor
3	Fire Station						
	Office area, Training room, Kitchen / Dining area, Dormitory,	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern for office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic	Acrylic Emulsion paint over white cement wall putty. Office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of	Acrylic Emulsion paint Air conditioned areas (office room) shall have Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top. of approved	Aluminium glazed door/ hollow metal flush door	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High.	approved make topped with 50 mm wide matching ceramic trims 2200mm. High.	make as per specification			
	Stores	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height.	Acrylic Emulsion paint	Hollow metal flush fire door	-Do-	
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Fire tender parking area and equipment store	50mm thick heavy duty cements concrete Granolithic flooring with metallic hardener with matching skirting. or Paving with 75 mm thick pressed interlocking precast blocks	External quality acrylic emulsion paint and for equipment store Acrylic Emulsion all be used	For Parking area External quality acrylic emulsion paint and for equipment store Acrylic Emulsion shall be used.	Aluminium glazed door/ hollow metal flush door for equipment store	-Do-	
4	Weigh-bridge control room.	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern.	Vitrified tiles dado up to 1.50 m height and Acrylic emulsion paint over white cement putty for balance height	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	Toilets for Gents shall be provided.
5	First Aid Centre						
	Reception, waiting area, Minor OT, Doctor 's chambers &rest room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting.	Vitrified tiles dado up to 2.1 m height and Acrylic emulsion paint over white cement putty for balance height	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	

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SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Other areas	Kota stone flooring(overall 50mmthick) and skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint for balance height	Acrylic Emulsion paint	Solid core flush door	-Do	
	Toilet & wash areas	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided, Along with toilet for Physically challenged
6	Construction Stores						
		50 mm thick heavy-duty cement concrete floor with metallic hardener and	Acrylic Emulsion paint with white cement putty for office & AC	Acrylic Emulsion paint over white cement putty. Air	Hollow metal flush fire door/	Powder coated and UV protected	Toilets for Gents and ladies shall be

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INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		matching skirting. For office areas & AC stores vitrified tiles shall be used.	store areas and Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint with white cement putty(full height) for balance height for other areas	conditioned areas shall have Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top. of approved make as per specification	Aluminium glazed door. Rolling shutter wherever necessary	Aluminium glazed window / ventilator	provided
7	Car and Cycle/ Scooter stand	Minimum 75mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over RCC under bed.		Single skin zincalume roof sheeting over Steel framed structure.			
8	Workshop						
	Workshop area	50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting.	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with for balance height	Acrylic Emulsion paint	Hollow metal flush fire door/ Aluminium glazed door. Rolling shutter wherever	Powder coated and UV protected Aluminium glazed window / ventilator	

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
					necessary		
	Office	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern	Acrylic Emulsion paint over white cement putty	Mineral Fibre Based Acoustic Ceiling Board false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	
	Electrical room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern and matching skirting 1.0m wide flexible electric insulated PVC synthetic sheet is to be laid in front of electrical equipment	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height.	Acrylic Emulsion paint	Hollow metal flush fire door	-Do-	
	Tool room, Store	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance	Acrylic Emulsion	Hollow metal flush door / fire door and door At the Main entrances	Powder coated and UV protected Aluminium glazed window /	

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
			height		collapsible door shall also be provided	ventilator	
	Toilets	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided
9	Permanent Store						
	Office, Store-in-Charge room, Challan receipt and issuing section, Record room,	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern with matching skirting.	Acrylic Emulsion paint over white cement putty	Mineral Fibre Based Acoustic Ceiling Boardfalse ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window /	

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Office Store, etc.					ventilator	
	Precision Material and Electronic Material Store	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern with matching skirting.	Acrylic Emulsion paint over white cement putty	Stove-enamelled Aluminium false ceiling, similar or equal to LUXALON with either lineal panel system or aluminium tile/plank system false ceiling with insulation on top.	Aluminium glazed door	Powder coated and UV protected Aluminium glazed window / ventilator	
	Toilets	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic Emulsion paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame &	-Do-	Toilets for Gents and ladies shall be provided, Along with toilet for Physically challenged.

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
					shutter.		
	Heavy Material Store & Light Material Store	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door and door At the Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	
	Store Keeper room	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	White cement wall putty. Synthetic enamel paint up to 1.50mts height and Acrylic Emulsion paint for balance height	Acrylic Emulsion	Hollow metal flush door / fire door and door At the Main entrances collapsible door shall also be provided	Powder coated and UV protected Aluminium glazed window / ventilator	

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
	Toilet s within Heavy & Light Material Stores	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic paint Emulsion	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	-Do-	Toilets for Gents and ladies shall be provided
10	Toilet Blocks (1 no for CHS , and 1 no for Boiler area)	10 mm thick non-skid fully vitrified tiles of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic Emulsion paint over white cement putty.	Acrylic paint Emulsion	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door	Powder coated and UV protected Aluminium glazed window / ventilator	One EWC , Two IWC , Two Bath rooms , 2 Urinals and 2 wash basins with mirror shall be provided



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

ANNEXURE –I

INTERIOR FINISH SCHEDULE

SL. NO.	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		floor finish level.			frame & shutter.		

Note: Wherever metal deck sheets are provided for the ceiling the painting for the exposed surface shall be as specified in clause 4.00.00 of this section





EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha

VOLUME: II-G/1

SECTION-V

**GENERAL SPECIFICATION AND DESIGN CRITERIA OF RCC
CHIMNEY [CIVIL & STRUCTURAL WORKS]**



Development Consultants Pvt. Ltd.

Vol. II-G1/Section-V
General Specification & Design Criteria
of RCC Single-Flue Chimney [Civil &
Struc]



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VOLUME: II-G/1

SECTION-V

**GENERAL SPECIFICATION
AND
DESIGN CRITERIA OF RCC CHIMNEY
[CIVIL & STRUCTURAL WORKS]**

1.00.00 GENERAL

1.01.00 SCOPE OF WORK

The Works as detailed hereinafter pertaining to RCC Single and Bi-Flue Chimney for the Coal based Thermal Power Plant to be constructed as (3 x 800 MW) near Kumbhari & Tareikela villages, Jharsuguda District, Odisha

- All civil and structural works for RCC Chimney with internally lined (borosilicate) steel flue enclosed by RCC Wind Shield to suit MOEF norms with Rack & Pinion Elevator. RCC Single flue Chimney height shall be as per statutory norms (MOEF) or minimum 150m, whichever is higher. RCC Bi-flue Chimney height shall be as per statutory norms (MOEF) or minimum 180m whichever is higher.
- Other Auxiliaries, Internal Steel Platforms, ladders, Rack & Pinion elevator etc.
- Structural steel staircase upto the topmost internal platform and from there cage ladder to roof of the chimney
- Duct supporting arrangements as per functional requirements
- RCC Approach Roads / Paving (as required) along with Street Lighting.
- RCC grade Slab & Service Drains as necessary.

One number of Reinforced Concrete Single-flue Stack for Unit 1 shall comprise of one no. internally lined (with Borosilicate) steel flue enclosed by a wind shield of reinforced concrete shell to suit MOEF norms with R&P Elevator

One number of Reinforced Concrete Bi-flue Stack for Unit 2 & 3 shall comprise of two no. internally lined (with Borosilicate) steel flue enclosed by a wind shield of reinforced concrete shell to suit MOEF norms with R&P Elevator

This specification shall be read along with Contract drawing 18A03-DWG-C-0004.

Sht 1 and Sht-2 for Single Flue and Bi-Flue Chimney.

The steel flue shall be vertically supported at top & at intermediate levels

(minimum 1 platform(s)) and horizontally restrained on steel platform at intervals satisfying all functional requirements. The steel platforms shall be supported on reinforced concrete shell wind shield. The suspended position of the steel flues shall be connected to the bottom supported position of the flues by expansion compensator so as to compensate for the large thermal movements of steel flue.

The scope of this work shall consist of, but not limited to, the design and construction of reinforced concrete windshield, foundations with associated pipe work, Borosilicate lining, stairs, cage ladders, rack & pinion type elevator, internal platforms, walkways as specified or required for operation and maintenance, access doors, handrails, steel fittings, fixtures, inserts including fabrication, galvanizing wherever required and erection of associated steel work and other chemicals on the completed structures etc. all complete as per functional requirements and as per directions of Owner.

The scope of work under this specification shall include providing engineering design and drawings, all labour, supervision, materials, shuttering and scaffolding including slip-form, construction equipments including cranes, hoists, batching plants etc. tools and plant, supply and transportation of all incidental items not shown or specified but reasonably implied for successful completion of the work. The nature of the work shall generally involve foundation, excavation, dewatering, shoring and strutting, backfilling around underground structures and plinth filling, sand filling, disposal of surplus soil outside plant boundary and as directed by the Engineer in charge, concreting of grade as specified, formwork including automatic climb form, fabrication, galvanizing (wherever required) and erection of steel structures and inserts, finishing anchor bolts etc. as required.

The contractor shall furnish the Slip form design including all detailing and analysis for Owner / Consultant for approval before taking up the shell work at site.

The scope shall include design, engineering, construction of RCC Chimney (one number single flue and one number Bi-flue) including all manufacture, assembly / pre-assembly, tests at manufacturer's works, shop painting, seaworthy packing, complete with all accessories, auxiliaries as specified hereinafter and as required for safe and trouble free continuous commercial operation

The scope of this specification also includes but not limited to erection / installation, supervision, including unloading, storage and handling at site, site testing, commissioning, other erection services to ensure trouble free operation and commissioning of the plant as per mechanical requirement.

The contractor shall carryout, at his own cost, model test of chimney in wind tunnel in an approved laboratory to investigate the aerodynamic behavior of the chimney. Effect of adjoining structures such as boilers, cooling tower and future expansion structures etc. on magnifying wind loading on the chimney shall be studied in a wind tunnel before the designs are finalized. A provision of 10% increase in the wind load forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs. Worst of the forces calculated as per as per codal requirements and forces obtained from wind tunnel study shall be considered as design forces for final



design of shell and foundation. Wind tunnel study has to be done in any one of the following approved labs - SERC-Chennai, and IIT – Kanpur and the study report shall be got approved by the owner / Consultant. The model test shall be duly witnessed by the owner and the Consultant.

The flue ducts shall be entering as per FGD mechanical layout requirement.

1.02.00 General parameters of the chimney

Total height or the chimney above FFL. : As mentioned in
Clause No. 1.01.00

One number RCC Wind shield (shell) enclosing One steel flue for Unit 1 Boiler and one number RCC Wind shield (shell) enclosing two steel flue for Unit 2 & 3 Boilers

No. of Boilers. : Three

Flue liner sizing shall be done based on for volume of gas (to be estimated by contractor, when firing the specified worst coal at BMCR load, considering 25% excess air at economizer outlet, 15% Air heater in leakage & 2% duct and 1% ESP leakage as a minimum.) for FGD in operation case, as well as for FGD by pass case. However flue liner shall with stand gas temperature without FGD operation condition.

Stack Exit velocity : Maximum 18.3 m/s
(With Borosilicate
block lining as per
EPRI guidelines)

Inlet-duct center line elevation. : } During Detail
Duct opening Dimensions. : } Engg. Stage

Minimum top internal shell diameter. : To be decided by
Contractor

Minimum bottom internal shell diameter : To be decided by
Contractor

** The contractor shall use Geotechnical recommendations available in the tender document for various locations, depths and widths for reference for estimation purpose. Moreover, contractor is at liberty to carryout suitable number of borehole tests at site to assess the Net Safe Bearing Capacity/pile capacity values for design of foundation prior to quote. After contract award, the contractor shall conduct detailed Geo-technical investigation. After completion of detailed Geo-technical investigation, the draft Geo-technical investigation report shall be submitted to



owner/consultant for review/Approval. During the review/Approval, The recommendations furnished by contractor shall be compared to the recommendations available in the tender document for various locations and depths. During the review, owner/consultant shall offer their suggestions/remarks on the contractor's draft Geotechnical investigation report, If any. The design, type, size, depth of the foundation/pile, Net safe bearing capacity/pile capacity values shall be based on the approved soil investigation report of the Contractor/Owner's soil recommendations (Available in the Tender document) whichever is conservative.

1.03.00 The windshield shall be of RCC construction. Flue shall be supported on the top of platforms. Platforms shall be provided at regular interval. The flue ducts shall enter as per the approved layout.

1.04.00 All internal platforms shall be supported on R.C. shell of the wind shield. Internal structural steel staircase for access to all platforms shall be provided. Rolling shutter (electrically operated) and one Steel Door at grade floor level shall be provided for access into the windshield and on to the platforms. All doors like inspection/ maintenance doors shall be as per IS code / environment regulation.

1.05.00 Natural Ventilation within the windshield shall be provided as required.

1.06.00 **Process Criteria for Wet Chimney**

i) Treated flue gas from the absorber shall be discharged through the chimney flue. The wet flue of chimney shall be suitably lined. The flue duct shall be lined with 51 mm thick Borosilicate glass block. External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm Titanium sheet (**Grade 2 as per ASME SB265**) over insulation. The design & construction of steel chimney liners shall be based on the guidelines of EPRI Revised Wet Stack Design guide

ii) **Wet Chimney Condensate Collection System**

To avoid the carryover of the condensate/acidic dews/water droplets/ gypsum coming out of the wet chimney a condensate collection system shall be provided. Design of the condensate system shall be such that the liquid condensate film near the exit of the stack is collected in the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the nearby area.

iii) **Wet stack model study**

A wet stack model study shall be performed by the Contractor for each unit with a wet stack installation where there does not exist an identical or mirror image installation that has already had a wet stack study performed. A wet stack model study shall consist of the following:

- a) Condensation calculations.
 - b) Minimum 1:12 scale physical flow model for liquid collector design.
 - c) Computational flow model for plume downwash analysis.
 - d) Physical or computational flow model for CEMS elevation flow performance.
- iv) Liquid collectors shall be designed and developed experimentally using a physical model. The model shall begin at the outlet of the absorber mist eliminator(s), including the absorber outlet and ducting, the stack breaching duct and a minimum of three (3) diameters of the stack liner above the top of the stack breaching duct. Physical model shall include any internal devices that may affect the gas flow, such as structural members, flow controls, and expansion joints. Liquid collectors shall be located where needed in the absorber outlet, the ductwork between the absorber outlet and the chimney liner, in the chimney liner, and in the exit nozzle. These collectors shall collect liquid from surfaces, prevent re-entrainment, and guide the liquid to locations where it can be drained out of the system and prevent the discharge of droplets from the top of the stack that are large enough to drain out to the ground before evaporation.

Necessary reiteration of model study shall be done for finalizing the ducting and flue can design.

- v) All chimney condensate collection equipment shall be easily accessible for O&M. The design of the stack condensate collection system including that are covered under model study shall be provided by the contractor in their bid. The Laboratory where the condensate collection study is to be conducted is to be approved by the Owner/Consultant and report shall also be submitted for approval by Owner/Consultant.

- vi) Chimney Liner Materials

All materials shall conform to IS Codes. However, the following shall apply: The flue duct shall be lined internally with Borosilicate glass blocks of 51mm thick and shall be lined as recommended by the manufacturer.

External surface of chimney flue can projecting over the chimney roof shall be wrapped with 2 mm thick Titanium sheet (Grade2 as per ASME SB265).

The lining material shall withstand a temperature of not less than 305°C for continuous operation of maximum 30minutes duration.

1.07.00

SPECIFICATION FOR BOROSILICATE LINING

Borosilicate Glass Block Internal lining material, for the flues for the entire height including the lining of flue gas duct up to chimney inlet flange (including transition duct).

- i) Borosilicate Cellular Glass Block, 51 mm thick,

- ii) Epoxy Primer
- iii) Adhesive membrane
- iv) Stack condensate collection system to avoid the carryover of the condensate/acidic dew/water droplets coming out of the stack.

Borosilicate Blocks:

The lining system shall use closed cell borosilicate glass blocks with the following physical properties:

- i) A coefficient of linear thermal expansion not greater than $5.5 \times 10^{-6}/^{\circ}\text{C}$, as per ASTM E228
- ii) Compressive strength of at least 1.1 N/Sq.mm as per ASTM C.165
- iii) Flexural strength of at least 0.62 Mpa as per ASTM C.203/C.240 shall be followed
- iv) Thermal conductivity of 0.087 W/m $^{\circ}\text{K}$ at a mean temperature of 38 $^{\circ}\text{C}$ as per ASTM C177 or ASTM C518

Adhesive membrane

The adhesive membrane shall be a 2-component urethane asphalt mastic having excellent elastomeric properties and be acid & heat resistant. The adhesive membrane shall be applied in between and behind the blocks in a 3.2mm thick layer ensuring a proper bond and adhesion. The adhesive membrane shall have the following properties.

- i) Tensile strength at 23 $^{\circ}\text{C}$ of 1.0 N/mm² (minimum) as per ASTM D.412
- ii) Elongation at 23 $^{\circ}\text{C}$ of 147.0 % (minimum) as per ASTM D.412
- iii) Moisture vapor transmission of 0.0048 Perm inches (maximum) as per ASTM C.96
- iv) The adhesive shall show no slump after 5 hours conditioned at 60 $^{\circ}\text{C}$ with a film thickness of 3/32" as per ASTM 6511, standard test methods for solvent bearing bituminous compounds, section 12 behavior at 60 $^{\circ}\text{C}$.

Specification of primer

Primer to be applied on steel substrate receiving borosilicate glass block lining system shall have the following properties including thickness, physical & chemical properties.

- i) The primer shall be a high performance epoxy primer. the primer shall be applied in 1 layer with a WFT of 3 to 5 mils

- ii) The primer shall be applied either by rolling or spray gun. Welds and joints shall receive an additional layer of primer by brush prior to rolling or spraying.
- iii) The solids by volume of the high performance epoxy primer shall not be less than 50%.
- iv) The bonding of the primer to the steel shall be at least 1400 psi. as per ASTM D4541.

Specification for surface preparation for steel substrate.

- The steel surface shall be grit blasted to a cleanliness of SA 2 1/2 and approved by the supplier of the lining system/
- The substrate shall thereafter be primed using a high performance epoxy primer within a short time window approved by the supplier.

Wet stack properties of the lining system

The lining system (borosilicate glass block and adhesive) shall be tested for its wet stack surface properties by an independent approved institute, subject to acceptance by the Purchaser, and has during such testing been shown to allow, without any significant re-entrainment of flue gas condensate, a flue gas velocity of 18.3 m/s.

Contractor shall provide a project specific "Wet Stack" study, performed by an independent approved institute like 'ALDEN', subject to acceptance by the Purchaser, indicating the correct placement and design of liquid collection gutters and liquid drains to ensure minimization of liquids and condensates entering the chimney.

Installation of Borosilicate block lining system

Surface Preparation & Surface Cleaning

Lining of the chimney shall include necessary cleaning, surface preparation and all arrangements for man material shifting, approach facilities, inspection etc.

Mixing of Adhesive Membrane

- The Adhesive membrane shall be mixed according to the direction for the product use in the correct mixing ratio.
- The temperature for mixing the main material and hardener shall be as per OEM recommendations.
- Appropriate mixing method shall be used for equal mixing and shall be blended for the required appropriate time.

- Sufficient time shall be allowed for curing

Mixing machine

- Mixing machine shall be used for preparing the 2 component Adhesive Membrane on site.
- The mixing machine must be CE – approved.
- Mixing machine type and motor rating shall be as per OEM Standard practice / recommendations.
- The mixing machine shall have thermal motor protection to minimize failure and fire risk.
- Adequate number of mixing machines shall be employed for completion of the installation works for the three units/flue cans within the scheduled time.

Mixing of Epoxy Primer

- Epoxy Primer shall be mixed according to the direction for the product use
- Mixing ratio shall be as recommended by OEM
- Epoxy Primer shall be blended by using Mechanical Mixer for the required minimum time.

Installation of Borosilicate Block

- The Adhesive membrane shall be applied as per the instructions of OEM.
- Arrange the borosilicate glass blocks such that there is no blank space between the block and surface. The adhesive shall fill the side joint and flow out to the edge. The block shall completely stick to adhesive applied on the surface.
- Block whose edge is broken shall not be used.
- All the equipments and tools required to install Borosilicate Glass Block lining system including Polyethylene film, Rag, Wire brush, Plastic sink, Electric drill, Jiffy Mixer Blade, Insulated saw, Float, Paint brush, hand cleaner, Cleansing glove, Hygrometer, Surface thermometer, white chalk, white spray etc as required shall be arranged by the contractor.
- It is important that the liner substrate be fully covered with the adhesive material to ensure that a continuous chemical- and moisture-resistant barrier is formed between the inside and outside of the flue. A nominal adhesive thickness of 3.2 mm is recommended behind and between each block. A 1.6-mm thick layer shall be troweled onto the liner, as well as to the sides and back of each block, before installation. This double-buttering technique

ensures a full bond of each block to the liner and to each other. Excess adhesive material squeezed out during placement of the block shall be struck clean.

Ensure the proper radial alignment of the blocks and to strike the adhesive/mastic flush with the inside surface of the liner. The surface of the block shall be clean and free from smeared adhesive/mastic material. If the maximum projection or offset between bricks on the interior surface of the liner shall not exceed (3.1 mm).

Inspection

- Inspection and testing including adhesion shall be as per approved QAP.
- The mixing, curing and adhesion characteristics of the adhesive membrane shall be evaluated by applying it onto a test area of the same material and surface preparation of the substrate. Work life and initial set time may be visually observed. Cure shall be uniform.
- The installation procedure of the lining system shall be verified by installing the system on a transparent panel. Visual inspection shall be made of back, end and side joints.

Testing

- Borosilicate Lining Block shall withstand Hydrolytic resistance as per ISO 719.
- The lining system manufacturer shall demonstrate a proven quality control system that monitors and documents the key physical properties mentioned in the specification.
- Contractor shall check and provide satisfactory proof to owner, that the back joint adhesive of the borosilicate lining system shall not exceed its supplier recommended operating temperature during any operating condition that can occur before and after FGD system commissioning.
- The Borosilicate Block shall withstand EPRI parameters of 18.3 m/s velocity and the same shall be certified by a reputed agency like M/s ALDEN (with the name of the supplier). The Test report/Test Certificate shall be submitted for approval by the owner/consultant.
- The lining shall be tested at internationally reputed laboratory such as Glass Technology Services, UK or equivalent subject to acceptance by project owner for suitable use in aggressive hydrolytic attack scenarios such as exposure to flue gas condensates using Glass durability Modeling and Hydrolytic Resistance Test as per ISO 719

Heat cycling resistance

- The lining system shall also to withstand excursion temperature of 300oC for 30 minutes during air preheater trip condition. The duration of heating and cooling shall be as per supplier's recommendations. Number of cycles-3.

On site supervision and QA/QC services

- The lining system (borosilicate glass block and adhesive) supplier shall provide on-site technical support and QA/QC supervision, and shall employ QA/QC supervisors with a demonstrated experience of at least 5 years in technical support and QA/QC supervision of the subject lining system.

Performance, safety and fire risk

- The lining system (borosilicate glass block and adhesive) shall be tested and certified for fire risk by an approved institute of sufficient knowledge and experience (FM GLOBAL, LONDON or equivalent) subject to acceptance by the Purchaser, and thorough testing demonstrated the ability to protect the steel flues from structural damage for a minimum period of 2 hours, as per relevant ASTM standards ASTM E-119.

Requirement in Flues

Sample Point

- Borosilicate block primer and high nickel steel bar shall be applied to sample points to make it acid resistant.
- The nozzle (Pipe tube) shall be of suitable alloy steel to withstand design operating environment.
- Nozzle shall be fully seal-welded both inside and outside of the steel duct plate. The inside weld shall be ground smooth.
- The nozzle shall be flanged and not threaded.
- The Glass Blocks shall be Cut and shaped as required to fit. The block shall be fully bonded to the exterior surface of the nozzle with adhesive membrane.

Manhole and Access doors

- Manholes/Access doors shall be modified by application of borosilicate blocks.
- High nickel alloy stop bars of 2mm thickness for protection from acidic condensate.
- Fibre gaskets shall be used for sealing.

Collection gutter



- The condensate generated in flue gas while FGD is under operation, shall be collected and discharged from bottom of the flues.
- The material of gutter including drain and base plates shall be made of suitable alloy steel to withstand design operating environment.
- All welds shall be full seal welds.
- The surfaces of the alloy materials which shall be in contact with the lining system shall be blasted and primed with Epoxy Primer.
- The Glass Blocks shall be fully bonded to the alloy steel.

Expansion Joints (if any)

- Expansion joints cannot withstand the acidic flue gas during FGD operation and hence shall be provided with acid resistant elastomeric fabric bellows.

Documentation

- a) Documentation shall, as a minimum, comprise the following.
 - i) All drawings including shop drawings for the above works and supply.
 - ii) O&M Manual, Installation & Instruction Manual.
 - iii) Submission of comprehensive QA documentation after the completion of the lining process in the flue can.
- b) All relevant drawings/documents/data including supply of equipments, not specifically mentioned above but deemed essential for successful completion of the lining work shall also be furnished/ supplied by the Contractor for approval.
- c) All other miscellaneous equipment and accessories required for a complete functional system which meets the intent and requirements of this specification shall also be furnished by the contractor.
- d) Condensate / acidic dews / water droplets coming out of the stack.

2.00.00

CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design. The latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

a)	IS: 456	-	Code of practice for plain and Reinforced Concrete.
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b)	IS: 800	-	Use of Structural steel in general Building Construction.
c)	IS: 875 (Part-3)	-	Code of Practice for Wind Loads.
d)	IS: 1786	-	Cold twisted steel bars for Concrete Reinforcement.
e)	IS : 432	-	Mild steel and Medium steel Bars
f)	IS: 1893 (Part 1)	-	Criteria for Earthquake Resistant Design of Structures: Part 1- General Provisions and Buildings.
g)	IS: 1893 (Part 4)	-	Criteria for Earthquake Resistant Design of Structures: Part 4- Industrial Structures Including Stack-Like Structures.
h)	IS: 4998	-	Design of Reinforced Concrete Chimneys - Criteria
i)	IS: 6533 (Part 1 & Part 2)	-	Design Construction of Steel Chimney – Code of Practice
j)	Reference may also be made to ACI: 307 “Specification for design and construction of R.C. Chimney”, If some items are not covered in Indian Codes.		

- i) ASCE-1975 : Design and construction of steel chimney liners prepared by Task committee on steel chimney liners, Fossil Power Committee

Books:

- a) Tall Chimney - Design and Construction By S.N. Manohar
b) Reinforced concrete chimney tower By G.M. Pinfold

3.00.00

GRADES OF CONCRETE AND STEEL

Grade of concrete for foundation raft /pile cap and windshield shall be M30 (minimum) with cement content of 400 Kg/m³ as per Technical Specification for Cement Concrete (Plain and Reinforced). Ordinary Portland cements namely Grade 43 conforming to IS: 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations. However the Ordinary Portland cement (Grade 53) may be used with approval by the Owner- Only one grade of concrete shall be used throughout the height of the shell.

High yield strength deformed bars of grade Fe500 CRS conforming to IS 1786 shall be used as reinforcement. Grades Fe500D CRS / Fe550 CRS/Fe550D CRS may also be used but for the design of primary reinforcement, the grade shall be restricted to Fe 500 only & for design of secondary reinforcement (stirrups & ties), the grade shall be restricted to Fe 415 only. Test certificate for reinforcement steel shall be obtained from recognized agency, before using by the contractor. If the steel is purchased by the contractor, Engineer may desire to check the testing of the same & the contractor shall arrange it in approved laboratory at his own cost.

Structural Steel sections and plates having yield stress 250 MPa conforming to IS: 2062 shall be used. Plates for steel flue shall be Mild steel of minimum 8 mm thick confirming to IS:2062 having yield stress of 250 MPa.

4.00.00 DESIGN CRITERIA

Design and construction of various components and systems of the chimney shall be in accordance with relevant Indian Standard and where provisions are not covered in IS, reference shall be made to ACI, BS, CICIND and other international standards.

4.01.00 Loading

4.01.01 Dead Load

All permanent loads due to the weight of chimney shell, internal steel platforms, linings, ladders, flue ducts, staircases, Elevator and other accessories etc.

4.01.02 Imposed Loads

- i) Imposed load on service platform around Chimney shell, shall be taken as 500 Kg/m². Design live load during construction / erection shall be considered as 1000 Kg/m².
- ii) Imposed loads from duct joining the Chimney shall be considered.

4.01.03 Wind Load

The wind loading shall conform to Latest version of IS 875 (Part-3). Following parameters shall be considered for assessing wind loads:

Basic wind speed = 44 m/s at 10m above mean retarding surface.

k1 = 1.07 as per Table 1 of IS 875 (Part-3) (Latest) corresponding to 100 years return period.

k3 = 1.0

k2 = As per IS 4998 (Latest).

k4= As per IS 4998 (Latest) and IS 875 (Part 3) (Latest).

Aerodynamic Interference Effect (proximity effect) due to presence of other tall structures and stacks in the vicinity shall be assessed based on wind tunnel test to be carried out by approved specialized agency and shall be incorporated in

design.

Profile (diameter, thickness etc.) as well as wind forces (moment/shear etc.) at different sections/levels of chimney shall be calculated as per structural analysis conforming to requirements of IS: 4998 (Latest) and Contract Specification. Wind Tunnel study as specified elsewhere shall be carried. Worst of the forces calculated as per codal requirements and forces obtained from wind tunnel study shall be considered as design forces for final design of shell and foundation or as per any relevant codal requirements justifying the final design forces. Wind Tunnel Study shall be conducted in any one of the following approved Labs/Institutes - SERC-Chennai, & IIT-Kanpur and the study report shall be got approved by the Purchaser / Consultant. The model test shall be duly witnessed by the Purchaser and the Consultant and get approved by NLCIL/Consultant.

4.01.04 **Seismic / Earthquake Load**

Calculation of earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893 (All Parts) (Latest) [Zone –III] using the Response Spectrum Method. Material damping factor and number of modes to be considered for the analysis shall be as per recommendation in the code referred above. The number of modes to be considered in the analysis shall be such that at least 95% of the modal mass is excited.

4.01.05 **Thermal Effect**

Thermal effect due to established thermal gradient shall be duly considered as per provisions in relevant IS code.

The temperature gradient ΔT across the shell thickness of wind shield shall be calculated as per IS: 4998 (Latest) but subject to a minimum of 30°C. The temperature stresses shall be calculated according to the procedures given in ACI – 307 and IS: 4998 (Latest).

4.01.06 **Local Loads**

The effect of following local loads shall be considered.

- a) Local moment produced by corbels (if any).
- b) Local moment due to platforms.
- c) Local moment due to occurrence of ovaling oscillation.
- d) Local moment produced by thermal gradient.

4.01.07 **Load Combination**

Various load combination for calculation of stresses shall be as under.

- i) Dead load \pm Wind load.
- ii) Dead load \pm Earthquake effect.
- iii) Dead load \pm Temperature effect.

- iv) Dead load \pm Wind load \pm Temperature effect.
- v) Dead load \pm Earthquake force \pm Temperature effect.
- vi) Circumferential stresses due to temperature effect.
- vii) Circumferential tensile stresses due to wind induced ring moment.
- viii) Circumferential compressive stress due to wind induced ring moment combined with temperature.

In Load combinations (i) to (viii) above, dead load considered shall be with or without the weight of flue, whichever condition is more critical shall be adopted for design. Across wind loads shall be combined with co-existing along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-existing along winds loads.

Limit State Method of Design shall be followed as per Latest IS 4998.

5.00.00 ANALYSIS

5.01.00 Free Vibration Characteristics of Wind Shield

Assessment of Natural Frequencies and mode shapes shall be carried out. For this purpose the Chimney shell shall be idealized as a vertical cantilever with Lumped masses at different nodes. The nodes shall also be provided at each platform level.

The number of modes to be considered in the analysis shall be such that at least 95% of the modal mass is excited.

5.02.00 Wind Loads

5.02.01 Along Wind Load

Along wind load shall be assessed based on methods specified in latest version of IS 4998. Dynamic modulus of Elasticity of concrete as recommended in latest version of IS 4998 shall be used for evaluating the natural frequencies.

Mean drag coefficient 'CD' shall be taken and considered for the concrete shell as per IS 4998 (Latest).

5.02.02 Across Wind Loads

The across wind response due to vortex shedding of the Chimney shall be evaluated as per the method given in IS 4998 (Latest).

5.02.03 Ring Moments due to Wind

The circumferential ring moment due to wind shall be calculated in accordance with of IS 4998 (Latest).

5.03.00 **Seismic Analysis**

The Seismic Analysis shall be carried out as per IS 4998 (Latest) using the Response Spectrum Method according to IS 1893 (Part-4) (Latest) taking the first 5 modes (minimum) of vibration into account. 5% damping shall be considered for the analysis. Seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS 1893.

5.04.00 Chimney shall be designed without considering provision of strakes.

6.00.00 COMPONENT DESIGN CRITERIA

6.01.00 **Wind Shield and Foundation**

The design conditions for the concrete shell shall be as follows:

- 1) The concrete shell shall be analysed & designed for loads and load combinations as specified in IS 4998 (Latest) & IS 1893 (All Parts) (Latest). Limit State method shall be used for design of shell.
- 2) The concrete shell shall support all platforms, which in turn supports the flues. The beams supporting the platform shall be made to rest on the shell by making a pocket in the shell with necessary embedding/fixing arrangements. Suitable Elastomeric bearing pads duly approved by Owner/Consultant shall be provided below the beams. These bearing pads shall be designed against temperature effect and horizontal shear due to seismic loads. The diameter of flue and RCC wind shield shall be so chosen as to allow for sufficient clearance to accommodate essential accessories like staircase, elevator, test probes etc. The space shall also ensure adequate ventilation around the flue and maintenance requirements.

Uniform concrete grade shall be used for chimney wind shield.

- 3) The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than $H/500$ where H is the total height of the windshield above top of the foundation.
- 4) The static modulus of elasticity of concrete for various concrete grades shall be taken as specified in IS: 456.
- 5) The dynamic modulus of elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS: 4998 (Latest).
- 6) Reinforcement in the shell shall be provided as per IS: 4998 (Latest). However, the maximum spacing of reinforcement shall not be more than 250 mm both ways in the shell and 300 mm for foundation raft.

For Vertical reinforcement, Minimum reinforcement shall be 0.3% of the overall concrete section under consideration. For circumferential reinforcement, minimum reinforcement shall be 0.20% of the overall concrete section under consideration subject to minimum of 4cm² per metre height of the stack. The circumferential reinforcement shall be placed nearer to the faces of the shell.

The circumferential reinforcement for a distance of 0.2 times diameter of the Chimney (from top of the chimney) shall be twice that required from design forces. The clear cover to reinforcement shall be 50 mm. One third of the vertical bars can only be lapped at one section.

There shall be a continuous ring of concrete shell without any opening for a height of at least 5m below the soffit of flue duct openings.

There shall not be any reverse (outward) slope in the inside face of chimney shell. Where there is a change in slope/ profile of the shell, the circumferential reinforcement shall be increased to twice the requirement as per the design in a circumferential band extending atleast 3m above and below such slope/profile change level.

The diameter of the reinforcing bar for the main vertical reinforcement of shell shall not be less than 25mm for a shell height upto the top level of flue duct opening.

Shell thickness between any two 10m reference levels shall not vary more than 150mm.

- 7) Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. as required. The maximum width of opening shall be limited to an angle of not more than 45° subtended at the center of the concrete shell. The effect of the openings/cut-outs in the chimney shell shall be duly considered in the design of the windshield.

The total plan area of the openings at a particular section shall not be more than 20% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening. The extra reinforcement around opening shall satisfy the requirements given in the latest versions of the following documents and the highest shall be provided.

- a) IS: 4998
 - b) ACI 307
 - c) Reinforced concrete chimney and tower by G.M. Pinfold.
- 8) Suitable foundation to support the staircase shall be provided as required.
- 9) Staircase and elevator enclosures shall be provided keeping provision for

a rack and pinion type electrically operated elevator.

- 10) Minimum thickness of wind-shield at top of chimney shall be 300 mm and the minimum thickness of the RCC shell at the top of raft shall be 600mm for single flue chimney and 850mm for Bi-flue chimney. However, shall be matched with guidelines provided in IS: 4998 (Latest version).
- 11) Uniform Grade of concrete shall be adopted throughout the height of chimney shell.

6.02.00 **Steel Flue**

6.02.01 **Material**

- 1) The flue can shall be of steel type "Mild steel of minimum" of minimum 8 mm thick. Flue can projecting above the chimney roof slab shall be mild steel with 8 mm minimum thickness wrapped with Titanium liner 2 mm thickness with suitable support. The height of the flue shall be as per the design requirement. Insulation outside the flue can above the roof is not required. Acid resistant Borosilicate brick lining shall be provided at inside face of the flue.

Design of Steel flue can

Steel flue can, shall, in general, be designed meeting the requirements of the document, "Design and construction of steel chimney liners", prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.

- 2) Stainless steel flue-Liner Hood / Cap of flue can shall be fabricated using material conforming to AISI 316L or BS: 1449. Grade of steel shall be equivalent to BS: 1449 (Part 2) 316 S.12.

At Load Bearing and Side Restraints of Flues

Load bearing insulation assembly to have (i) a properly machined mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead / elastomeric sheet at top, and (iii) top plate formed of two numbers insulation blocks each made of minimum 50 mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) or equivalent bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 or equivalent and stainless steel plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and mild steel to IS:2062. SINDANYO BLOCKS or equivalent shall be suitable for operation at 320oC and shall primarily satisfy the following physical properties:

- i) Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.

- ii) Minimum shear strength of 30 N/sq.mm when tested in accordance with BS:3497.
 - iii) Thermal conductivity shall not exceed 0.67 W/m Deg.C at a mean temperature of 200oC and its coeff. of linear expansion not to exceed 1.2×10^{-5} per Deg.C.
 - iv) Adhesive used for bonding purposes shall be of material with equivalent high temperature properties as approved Foundation Engineer. It may be of "Fortafix Fiborclad Adhesive" as manufactured by Fortafix Ltd., England or equivalent.
- 3) The expansion joint in the flue liner shall comprise of non-metallic material suitable for wet stack operations of proven design, shall be acid resistant to withstand acidic flue gas condensates arising out of flue gas parameters & operating conditions (including FGD bypass condition) as specified elsewhere in the specification and shall also prevent dust accumulation. All the expansion joint, flange and fittings shall suitably be designed for wet stack operation to withstand acidic nature of flue gas condensate and care shall be taken that no condensate accumulation in the system.

The minimum trouble free operational life of expansion joint shall not be less than 40000 hours of operation from the date of commissioning. Sufficient approach space shall be provided all around expansion joint for inspection and maintenance

4) **Flue Support Arrangement:**

- a) The support brackets and bearing assembly shall be welded to the locally thickened portion of the flue and in turn support the flue on the support platform. The arrangement shall cater for thermal movements of liner elements in a smooth and easy manner. Alternatively, flue can be supported by hanger assembly arrangement.
- b) The support arrangement shall typically consist of the flue support shoe (which is part of the flue), flue support bracket which is connected to the shoe by a precision bolted connection. The bracket in turn is welded to a bearing assembly. The bearing assembly is later bolted to the support beams available.
- c) Suitable restraint brackets and stop plates of MS shall be provided to avoid excessive movement, and keep the different units of the bearing assembly in position.
- d) Restraint and support brackets shall also be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

6.02.02

Design

Flue size (internal diameter) shall be selected considering flue volume, head loss in duct, exit loss etc. Vibration frequency shall be maintained more than (+/-) 20% away from the fundamental frequency of the windshield. If this is not possible then a dynamic analysis shall be undertaken treating the flue and the windshield as a coupled system.

Following factors of safety shall be maintained for different load combinations:

Operating Condition	Load Combination	Minimum Factor of Safety
Normal	D+T+W/4	2.0
Abnormal Environmental	D+T+W or E	1.5
Abnormal Operation	D+T*+W/4	1.333
D, W, E = Dead, wind and earthquake loads T = Loads due to temperature T* = Loads due to abnormal operating temperature		

The liner shall be designed to safely withstand service loads as well as stress induced during its handling, transport and erection. At locations where the flue is stayed, frictional forces develop due to thermal movement. These forces shall be accounted for in design of the flue. The flue liner thickness shall be determined from structural and corrosion potential considerations. However, the minimum total installed thickness of flue liner shall not be less than 8 mm.

6.02.03

Liner Hood / Cap

The liner hood shall be fabricated from 10 mm thick stainless steel sheets of grade 316 L. The hood shall completely cover the annular area between the mild steel flue and titanium cladding. This shall prevent exposure from the surrounding flue gas environment. Special care shall be taken to provide sufficient overlap of the stainless steel flashing cladding over the shield plate attached to the chimney roof cap. This is to ensure that adequate protection is achieved for the liner within the wind shield from the elements. All sections of the cladding / flashing shield plate shall be anchored in place with stainless steel bolts / nuts. Slot holes shall be provided to make allowances for differentials expansions/ movements. The Chimney cap shall slope towards the inside of the chimney at an angle of approximately 30° to the horizontal.

6.03.00

Internal Platforms

6.03.01

Internal platforms shall be provided as required and meeting all functional requirement and shall be supported on structural steel beams. Structural steel beams shall be supported on the shell (by making pockets on the shell). The platforms shall be located not more than 45m intervals throughout the height of the chimney. Total nos. of internal platforms shall be 3 nos.(minimum). for single flue and 4 nos. (minimum) for Bi-Flue chimney. Except for the roof slab, all the

platforms shall be provided with GI coated 40mm plate x6mm bar gratings. All recesses of the intermediate platforms must be protected with hand railings of minimum 1.2m height using GI coated heavy duty pipes. Handrails will consist of 40 NB pipes conforming to IS: 1161 for vertical posts. Horizontal rails of 32 NB will be provided at the top and at 500 mm intervals below from top, Toe guard plate with 150x6mm flat at bottom. At least three horizontal pipes will be provided for handrail.

- 6.03.02 The platforms shall be designed for the following loads:
- 1) Dead loads, weight of flue, Weight of lining, if supported on the platform.
 - 2) Live load on the platforms during operation and maintenance @ 500 Kg/m² (min).
 - 3) Construction loads.
 - 4) Thermal loads.
 - 5) Effect of wind / seismic loads.
- 6.03.03 The platforms shall also be designed to accommodate displacements caused by the thermal deformations, shrinkage and creep.
- 6.03.04 The steel girders supporting the platforms shall be provided with shear connector. However, for the design of plate girder the composite section of slab and beam shall not be considered. Deflection of girders shall not exceed span / 600. However, deflection for secondary beams supported on main girder may be span / 325. All the girders & beams, platforms and handrails shall be provided with 3 coats of heat and acid resistant epoxy paint over one coat of primer.
- 6.03.05 Corrosion allowance 2 mm (min.) shall be kept in the design of plate girders.
- 6.03.06 The minimum thickness of web shall be kept as 12 mm for fabricated plate girders carrying the flue load.
- 6.04.00 **Foundation**

The contractor shall use Geotechnical recommendations available in the tender document for various locations, depths and widths for reference for estimation purpose. Moreover, contractor is at liberty to carryout suitable number of borehole tests at site to assess the Net Safe Bearing Capacity/pile capacity values for design of foundation prior to quote. After contract award, the contractor shall conduct detailed Geo-technical investigation. After completion of detailed Geo-technical investigation, the draft Geo-technical investigation report shall be submitted to owner/consultant for review/Approval. During the review/Approval, The recommendations furnished by contractor shall be compared to the recommendations available in the tender document for various locations and depths. During the review, owner/consultant shall offer their suggestions/remarks on the contractor's draft Geotechnical investigation report, If any. The design, type, size, depth of the foundation/pile, Net safe bearing capacity/pile capacity

values shall be based on the approved soil investigation report of the Contractor/Owner's soil recommendations (Available in the Tender document) whichever is conservative.

The chimney foundation shall be designed for the most critical combination of forces and moments, resulting from all possible combinations of the various loadings from the chimney system during all stages of constructions. Worst of the forces calculated as per codal requirements and forces obtained from wind tunnel study **or as per any relevant codal requirements justifying the final design forces** shall be considered as design forces for final design of foundation. The Foundation shall be checked for overturning and sliding considering maximum and minimum vertical load. There shall be no uplift & no loss of contact under the foundation for any loading condition. No allowance shall be made for wind and seismic load combination. Grade of concrete for foundation/pilecap shall be minimum M30. Necessary provision shall be made in foundation design for supporting the transition duct.

Annular raft/pilecap with hollow inside is not permitted. Foundation/pilecap diameter to depth ratio shall be maintained to around 10 and shall preferably not exceed 12. Minimum reinforcement shall not be less than 0.12% (of overall section under consideration) in either face and in each direction. Wind and earthquake shall be treated as normal load and no enhancement of stress is permitted on this account in soil, concrete and steel. No tension shall be allowed under the foundation during earthquake and wind. The effect of water table shall be considered and the foundation shall be checked for overturning and sliding for minimum and maximum vertical loads. Ground water table shall be considered at finished grade level for foundation analysis & design. The diameter of the reinforcing bar for the main radial and tangential reinforcement for the foundation/pilecap shall not be less than 25mm. The spacing of radial steel at the outer edge of the foundation shall not be more than 300mm.

One intermediate layer of reinforcement in foundation/pilecap shall be provided where the thickness exceeds 2000 mm. Two such intermediate layers of reinforcement shall be provided where the thickness of foundation/pilecap exceeds 4000 mm. Such reinforcement in each direction shall not be less than 0.06% of cross-sectional area of foundation/pilecap.

Concrete pouring sequence shall be such that no cold joints occur.

The shrinkage reinforcement shall not be less than 16mm deformed bars at 600 mm centres. In addition, vertical chair bars at 600 mm centres shall be provided to support these bars.

6.05.00 **Warning lights**

6.05.01 Warning lights can be installed on door mounted on RCC shell as per requirements of ICAO/DARA. External platforms not required.

6.06.00 **Roll – Up door**

6.06.01 Flue duct erection opening of sufficient size considering all aspects shall be

provided by the contractor. After erection, it may be covered with rolling shutter suitably.

Electrically operated rolling shutter of size 3.0m x 3.50m (minimum) shall be installed at Finished Floor level along with guides, hood, hardware, weather baffles, combination end locks and wind locks, mechanism and accessories as required for proper operation and weather protection. The complete details and specifications of rolling shutter shall conform to IS: 6248 (latest edition) "Metal Rolling Shutters & Rolling Grills". RCC ramp shall be provided for access from the road/ground level.

6.06.02 The door shall be installed in accordance with the details and the manufacturer's directions. When installed, the door shall be free from warp twist, or distortion and shall be lubricated and adjusted to operate freely and smoothly.

6.07.00 **Personnel / Access Doors**

6.07.01 A steel personnel door of size 1200mm x 2100mm shall be provided for access to the windshield at grade level in addition to the rolling shutter with RCC ramp approach.

6.07.02 **Clause intentionally deleted.**

6.07.03 One air tight Access door at roof of size 750 mm x 1000 mm in stainless steel shall be provided to cover access opening.

6.07.04 The doors shall be hinged and provided with positive locking device. The hinges required for connecting the door with door frame shall be heavy duty steel butt hinges conforming to IS: 1341 (latest).

The size and number of hinges required for each door shall be decided as per the overall weight of the door for smooth and trouble free operation under service conditions. The minimum size of the hinges shall be not less than 150 mm.

6.08.00 **Inspection / Maintenance Doors**

6.08.01 Two numbers steel leak proof doors (lined internally with borosilicate blocks) of size 750 x 1000 mm and 750 x 600 mm shall be provided diametrically opposite in each of the flues at each of those levels where internal platforms are provided.

6.08.02 Proper sealing arrangement shall be provided in the doors to ensure leak tightness.

6.09.00 **Hatches**

6.09.01 Hatches shall be provided as required for erection and maintenance. Suitable covers along with proper locking arrangement may be provided, if required, for safety of personnel.

6.10.00 **Elevator & Staircase**

Elevator and staircase within windshield shall be provided.

The travel of the lift shall be up to the last platform below the roof. Access to roof from the top most internal platform shall be provided through Galvanized MS Cage Ladder and access hatch with appropriate cover openable from inside the windshield.

Staircase with handrails for chimney shall be supported from top of chimney raft & from all internal platforms and not with chimney shell. The staircase shall serve all the intermediate levels. Staircase shall be constructed in Structural steel. The stair shall stop at last internal platform. The staircase in no case shall be inclined more than 35° angle with horizontal plane. Width of staircase shall be 1200mm. The riser shall be 150 mm and tread of minimum 250 mm. The handrails shall be applied three coats of high build heat resistant Epoxy paint over one coat of primer.

6.10.01 **RCC Grade Slab & Paving:**

RCC grade Slab shall be minimum 200mm thick and other details like sub-base treatment, minimum reinforcement etc. shall confirm to the details specified elsewhere in the specification.

6.11.00 **Painting**

The entire inside surface of the chimney shell, horizontal surface of the shell at top, underside of roof slab etc. shall be painted with acid & heat resistant black bituminous paint conforming to IS:158 (not less than four coats including one prime coat). Total dry film thickness (DFT) shall not be less than 150 micron.

Entire external surface of the windshield shall be painted in alternate band of signal red and white colour starting with signal red colour at the top and in line with aviation requirements. out of which top 50m shall be painted with acid and heat resistant polyurethane paint and rest of the outside surface shall be painted with synthetic enamel paint conforming to IS:5410 in alternate bands of red and white colour. Total DFT shall not be less than 150 micron (three coats over one coat of primer). Each coloured band shall be approximately 30m wide.

External painting shall have acid and heat resisting properties conforming to IS-158. Total dry film thickness (DFT) shall be at least 150 microns. The top of shell at the roof level shall be painted with three coats of approved paint over a thin coat of the same paint. The overall DFT shall be at least 230 microns.

All steel surfaces shall be painted with 3 coats of heat and acid resistant epoxy paint over one coat of primer. Special steel surfaces (such as Corten Steel, Stainless Steel, Hot insulated surfaces etc.) shall not be painted.

Surface preparation and paint application shall be in accordance with manufacturer's recommendation.

6.12.00

Sampling & Test Ports for Emission Monitoring

Flue gas sampling ports for on line Emission monitoring instruments & Test Ports for local sampling & testing fabricated from Duplex stainless steel pipes of standard schedule shall be provided on each flue can at access platform level.

Contractor shall provide one nozzle made of 200 NB Duplex stainless steel pipe and projected approximately 200 mm outside the steel flue wall with an upward inclination of 5 Degree with the horizontal plane of flue can for mounting of SO_x, NO_x & CO analyzer.

Two nozzles in diametrically opposite position made of 80 NB Duplex stainless steel pipe and projected approximately 200 mm outside the steel flue wall for mounting of Opacity monitor.

Contractor shall provide one nozzle made of 200 NB Duplex stainless steel pipe and projected approximately 200 mm outside the steel flue wall with an upward inclination of 5 Degree with the horizontal plane of flue can for flue gas pressure measurement.

Location of the Sampling & Test ports, on the stack, shall be selected as per latest CPCB guideline.

Access platforms shall be provided at all the sampling points or ports and thermo well installation points around the flue can to carry out maintenance works. The working plat forms shall be provided 1.25 meter below the sampling points or ports and thermo well installation points. In addition mounting platforms for Extractive type gas analyser sampling stations if any shall be provided with suitable access from the flue can staircase.

Temperature Test pockets with a stub of size M33X2 for installing thermo well shall also to be provided flue gas temperature measurement & correction for opacity measurement.

In addition to the above sampling ports for instrumentation purpose there shall be four gas sampling ports on the flue can at 90 degree apart with flanged ends for local sampling & testing. Contractor shall provide required counter flange, nuts, bolts and gaskets. Power connection with 240V AC, 15 A AC plug socket arrangement shall be installed at this platform level for operating the Test Instruments.

Contractor shall furnish the arrangement drawings for the sampling and test points for owner's approval during engineering. Any additional system / Process requirement shall be taken care by contractor.

6.13.00

Acid Proof / Chemical Resistant Protection to Roof

The chimney roof slab shall be of RCC supported on a grillage of structural steel beams. The roof shall be sloped outwards for drainage of water. Acid proof / chemical resistant tiles bedded on acid proof / chemical resistant mortar shall be provided for the protection of the roof slab. The intervening space between tiles

shall also be filled up by acid proof / chemical resistant grouts. The mortar shall be acid proof mortar – Potassium Silicate type resistant to Sulphuric Acid as per IS: 4832 Part I & IS: 4441. The mortar shall be used immediately after mixing.

Tiles shall be made of clay, feldspar or quartz and vitrified at high temperature in ceramic kiln. These shall be unglazed, free from deleterious material and shall conform to IS: 4457. Iron oxide in the raw material shall not exceed 2%. These shall show a fine-grained homogeneous fracture when broken and shall be sound, true to shape, flat and free from flaws and other manufacturing defects. Dimension of the tiles shall be 198.5 x 198.5 x 35 mm minimum. Depth of groove on the underside shall not be more than 3 mm. Compressive and tensile strength of tiles shall not be less than 70 N/sq.mm and 3.5 N/sq.mm respectively.

6.14.00 **Roof Drainage**

Rain water outlets and down comers to be provided for roof drainage shall be heavy DI pipes minimum 150mm dia and fittings conforming to IS: 8329.

6.15.00 **Transition Ducting**

Providing duct within chimney windshield above the breaching point, Flue gas expansion joint and Transition piece (Contractor's proven practice of following EPRI guideline is acceptable) shall be provided by the contractor within the chimney windshield. However, it is to be taken care by the contractor that there is perfect matching of flue can ID with that of transition duct and smooth finish at the connecting point. Apart from construction of chimney windshield and internal platforms, supply and erection of flue cans from the downstream of the FGD duct up to final discharge point in atmosphere shall be under the scope of EPC package. The duct work profile and the guide vanes as required to be done by Contractor shall be so configured and sized to achieve the desired flue gas flow characteristics and to minimize flue gas pressure losses. The duct work and its supporting structures if any shall be designed for the most onerous of the possible combinations of gravity loading, seismic loading, flue gas pressure loading and thermal loading. Like in the case of steel liners, the minimum thickness of duct plates shall not be less than 8 mm in any case from structural condition and corrosion allowance point of view.

The design, detailing, fabrication, erection etc. of the platform structure supporting the transitional duct within the RCC windshield shall be under the scope of contractor.

Refer to Contract drawing 18A03-DWG-C-0004.

6.16.00 **Flue Openings and Duct Work**

The concrete shell at flue duct entry shall be adequately protected against high temperature by cast able refractory lining and the gap between the shell and duct shall be properly sealed off by any other suitable seal.

The openings in the windshield shall be sufficiently reinforced to withstand design loads. Similarly the openings in steel flues shall be properly reinforced for receiving the flue ducts.

The R.C.C. shell shall provide support for duct work from the expansion joint to the chimney liner.

Exposed ductwork shall be insulated and lagged to protect equipment & prevent injury to personnel. The insulation and wire mesh shall be secured to the lagging by means of pins or prongs welded to the exterior sheet and spaced on intervals not exceeding 450 mm in both the directions. The insulation shall be impaled over the pins or prongs, wire mesh applied over the insulation and the insulation and mesh shall be held in place with speed clips.

6.17.00 **Electrical Conduit**

Conduits shall satisfy the requirements described in the Electrical Part of this SPEC in V-II-F1-Section-XIV.

7.00.00 **WIND TUNNEL TEST FOR CHIMNEY**

Wind Tunnel Test for the RCC stacks is to be carried out as specified elsewhere. A model test has to be performed in a wind tunnel to predict aerodynamic behaviour of the prototype without strakes. The technical details, location and other features of the stacks to be tested are to be provided along with necessary drawing showing stack outline, General arrangement Plan, section, elevation and mass details of the stacks and other details as required for the test.

The tests shall be carried out on the model of the proposed stacks considering without flue and with flue conditions. The model test shall be carried out without strakes. Interference effects due to presence of adjoining & future expansion structures to be studied along with other required parameters including detailed aerodynamic behaviors.

8.00.00 **CONSTRUCTION BY SLIP-FORM METHOD**

Chimney construction shall be carried out using slip form shuttering technique. Type of Slip-form proposed shall be indicated in the offer with sketches, drawings and description as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour shall be indicated. The chosen scheme shall be of a past proven design. Performance record of the scheme shall be submitted with the offer for review and verification by the owner / consultant.

The Contractor shall furnish a brief but comprehensive description indicating the plan, programme and method of work proposed, for the approval of Owner at the time of submitting Bid. This description shall include the following items:

- i) Type and description of Slip-form equipment and its accessories.
- ii) Design of scaffolding and staging.
- iii) Description of materials including admixtures to be used for construction.

- iv) Manpower planning, construction space required, standby arrangement.
- v) Rate of Slip-forming.
- vi) Proposed workability requirement of concrete and type of cement & admixture to be used.
- vii) Quality assurance programme.
- viii) Method of Transportation of material
- ix) Method of curing and rectification of defects.
- x) Planned interruption, if proposed and activities during planned interruption. Treatment of construction joint.
- xi) Contingency solution for unplanned interruptions.
- xii) Time of completion.

9.00.00

GUIDELINES FOR SLIP FORM METHOD

Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which shall be kept in view by Contractor, while quoting for Slip-form method of construction:

- 1) Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps may be adopted:
 - a) Shutter plates shall be smooth and shall be thoroughly cleaned. Before fixing them in position all the surfaces that shall be coming in contact with concrete to have a coat of epoxy paint.
 - b) In areas where concrete thickness is 750 mm or more rate of pouring shall be such that minimum slipping of shuttering is 100 mm per hour.
 - c) Mix design shall be such that it shall be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate shall be established to suit the purpose depending on availability of aggregates.
 - d) Mix design also shall be such that a slump of 50 mm is achieved at the point where concrete is placed under an ambient temperature of around 40 °C. This shall also keep vibration by needle vibrators to required minimum. Slump shall not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizers of approved manufacture may be added in mix to meet this

requirement. These admixtures shall be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40°C.

- 2) Care must be taken to prevent twist, which, predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person shall exclusively be assigned for this purpose.
- 3) Every endeavor shall be made to prevent any tilt in the shutter assembly. To achieve this, following steps need to be taken:
 - a) Performance of jacks shall be closely monitored and any defective one shall be immediately replaced. Difference in levels of opposite jacks at any instant of time shall not exceed 5 mm.
 - b) Loading on Slip-form truss/yokes shall be evenly distributed as far as practicable.
 - c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve shall have a minimum wall thickness of 3.25 mm and shall be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.
- 4) For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.
- 5) In designing the mix following aspects shall be borne in mind:
 - a) Cement used shall have an initial setting time of not less than 50 minutes and preferably shall have a specific surface around 3600 Sq.Cm. per gram.
 - b) Coarse and fine aggregates shall be well graded and rounded. These help to keep down water/cement ratio and also offer better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates shall preferably be used unless reinforcement detailing calls for lesser size aggregates.
 - c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content shall be 400 Kg. per Cu.M of concrete.

- d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds shall be between 0.1 and 0.2 Newton/ Sq.mm.
- 6) Large diameter vibrator needles shall not be used for vibrating concrete. Sizes of these needles shall preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units shall always be maintained on top of working deck at all time during the entire period of slip form operation. Concrete shall be laid in layers and vibrated properly to have sound concrete without any honey combs.
- 7) It is preferable to have membrane-curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights.
- In case, such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilization of the system.
- 8) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.
- It is desirable that jacking system, based on which the entire slip form system works, shall consist of jacks 3 Tonne / 6 Tonne capacity and a hydraulic pump with necessary pipe connections.
- Spacing of yoke legs shall preferably be kept within 2 meters to prevent overloading on jacks and consequent failure resulting in twist of the formwork.
- Jacking rods shall be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.
- 9) At least 30% spare jacks and jacking rods shall be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.
- 10) In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.
- 11) For effective utility of this technique following areas need careful attentions at the very conceptual stage:
- a) Detailed quality assurance programme.
b) Advance Planning and preparations.

- c) Arrangement for on-site supervision and adequate access facilities.
- 12). Slip Form Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. shall be prepared beforehand by executing agency and to be approved by Consultant before starting the actual work.
- 13). Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.
- Vertical reinforcements shall be kept vertical by providing suitable holders within the slip form system.
- 14). It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break shall be utilized for various maintenance activities, removal of jack rods etc.
- 15). Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists shall be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.
- For movement of personnel supervising the work a separate hoist must be arranged for.
- 16). The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.
- 17). Winches for lifting men and material and mixers, if located within unsafe area around chimney, shall be protected by adequate shelter from possible damage.
- 18). Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.
- 19). A small laboratory shall be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube-testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement shall also be kept for lasers.

- 20). In case of interruption in the course of slipping, the formwork shall be brought up above the already poured concrete and following measures shall be taken:

Provision of a key and additional reinforcement at the junction of new and old concrete.

- a) Slip form system shall be lowered to have a minimum overlap of 100 mm or so over previously cast concrete. Chipping of old concrete surface to remove laitance and washed with water jet and cleaned with compressed air and thereafter pouring a layer of neat cement grout.
 - b) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Consultant.
 - c) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.
- 21). It is preferable to suspend the construction work under high wind condition.
- 22). It is of utmost importance that for effective implementation of this system an Consultant proposed by contractor (duly approved by owner/Consultant) shall be fully conversant with Slip form technique with enough experience in planning and control of formwork shall be in overall command of the site and he shall be ably supported by well trained mid-level supervisory staff, skilled workers and operators.
- 23). Operation of slip form method of construction is a continuous one and it demands continuous inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.
- 24). While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities shall be carried out under the guidance of a qualified and trained safety Consultant.

Safety measures as listed below, but not limited to only these shall be adhered to:

- a) Safety helmets and belts to be provided to all supervising staff and workers.
- b) Safety nets to be provided below both inside and outside platforms as instructed by Consultant.



- c) Hand railing and toe guard to be provided around all openings and platforms.
- d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.
- e) Passenger hoist must have multiple ropes.
- f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure. Emergency standby generator must be kept ready during the entire period of slip form method of construction.
- g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

All The safety appliances including wire ropes shall be got inspected periodically by the approved statutory agencies and the inspected reports shall be submitted to the owner.

25). Permissible construction tolerances shall be limited to the following:

Variation in wall thickness	: (-) 5 mm, (+) 25 mm
Variation from Design Diameter	: (\pm) 25 mm or (\pm) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (\pm) 75 mm.
Out of Plumb in General	: 1 in 1000 of height subject to a maximum of 200 mm.

10.00.00 CONCRETE

10.01.00 Trial Mix, Grades of Concrete

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables:-

- i) Strength requirements of concrete: Table-2 of IS:456.
- ii) Concrete Mix Proportion: Table-9 of IS:456.



- iii) Minimum cement content/Cu.m. of finished concrete shall be as per IS-456.
- iv) Limit of consistency: As per Table of clause 10.04.00
- v) Cement/Total Aggregate Ratio: As per the following table.

**MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES
OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATES RATIOS**

Workability	Water/ Cement Ratio	Ratio by weight of cement to gravel aggregate		Ratio by weight of cement to crushed stone aggregate	
		20 mm. size	38 mm. size	20 mm. size	38 mm. size
Very Low slump 0-25 mm.	0.4	1:4.8	1:5.3	1:4.5	1:5
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4
	0.5	1:5.5	1:6.7	1:5	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7
	0.7	1:8	1:8.5	1:7.4	1:8
Medium slump 50-100mm.	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5
	0.6	1:6	1:7.3	1:5.2	1:6.2
High slump 100 - 175 mm.	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE -1:

Notwithstanding anything mentioned above, the cement /Total aggregate ratio is not to be increased beyond 1:9 without specific permission of the Engineer.

NOTE - 2:

It shall be noted that such high aggregate cement ratios shall be required or concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cube each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty-eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Owner/Consultant. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Owner/Consultant.

10.02.00 Batching of concrete

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer-in-charge.

10.03.00 Mixing of Concrete

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum shall rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer-in-charge, before a different quality of concrete is put through the mixer and also at the end of day's work.

10.04.00 Workability of Concrete

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedment, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slumps in chimney works shall be adopted subject to Engineer's approval unless stated otherwise. The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm. with standard concrete		Use for which concrete is suitable
	Min.	Max	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC with congestion due to reinforcement and inserts.

NOTE : The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer-in-charge.

With the permission of the Engineer-in-charge, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete. No extra payment shall be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer-in-charge, the compacting factor test, in accordance with IS: 1199, shall be carried out.

10.05.00 Placing and Compaction of Concrete

Concreting shall proceed in a manner directed by the Engineer-in-charge, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height, which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

10.06.00 Curing of Concrete

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Owner under able supervisor for curing and all cost for this purpose shall be borne by him.

The Contractor may adopt spraying of curing compound as per manufacturer's recommendation.

10.07.00 Construction Joints

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be

kept minimum and the spacing shall not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

10.01.08 Ordinary Concrete

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS:456.

11.00.00 REINFORCEMENT

11.01.00 Bending of Reinforcement

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that shall injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS: 2502.

11.02.00 Placing

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer-in-charge.

11.03.00 Fixing of Reinforcement

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

12.00.00 CHIMNEY STEEL AND METAL WORK FABRICATION (at Site / Shop fabrication)

12.01.00 General

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.

12.02.00 Fabrication

Rolled materials, before being used for fabrication, shall be straight and shall be

within the tolerance laid down in the IS:852. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat, the temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be affected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length, based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt-holes shall not be formed by a gas-cutting torch.

12.03.00 **Assembly**

Riveting, bolting and welding shall be carried out as per requirements laid down in IS:800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking, written in paint.

12.04.00 **Painting**

Painting shall be as per cl 6.11.00 of this section.

All steel surfaces shall be painted with 3 coats of heat and acid resistant epoxy paint over one coat of primer. Special steel surfaces (such as Corten Steel, Stainless Steel, Hot insulated surfaces etc.) shall not be painted.

Total dry-film thickness of paints provided on structures located outside windshield shall be 190 microns and that on inside be 125 microns minimum.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature and samples shall be submitted to the Engineer for his approval, before bulk purchase is made.

The metal surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

12.05.00 **Galvanizing**

Wherever Galvanizing is specified for steel including threaded bolts, nuts and washers in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS:2629 - Recommended practice for Hot- Dip Galvanizing of Iron and Steel.

Members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

12.06.00 **Erection**

Erection of structural members and Stainless steel Chimney caps shall be done as per requirement of IS:800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories as required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

13.00.00 **INSULATIONS AND PROTECTIVE TREATMENTS**

13.01.00 Borosilicate Lining

This shall be as per the relevant earlier clauses of this section.

13.02.00 Paint

The outside face of the Chimney shell, unless specified otherwise, shall be painted with alternate bands of signal red and white colour, with acid and heat resistant paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor, at his own cost, shall repaint the surface, until the Engineer is satisfied with the workmanship. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

13.03.00 **Lightning Protection System**

The lightning protection system to be installed on the chimney by the Contractor shall be strictly as per specifications and shall satisfy the requirements described in the Electrical Part of this SPEC in V-II-F1-Section-XIV



13.04.00

Aviation Obstruction Lighting System

The Contractor shall supply and install the aviation obstruction lighting system on the chimney strictly as per specification and shall consist of the items described in Electrical Part of this SPEC in V-II-F1-Section-XIV.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION-I
GUIDELINE
FOR
LAND SURVEY AND ESTABLISHING REFERENCE
GRIDS AND BENCH MARK PILLARS**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-I
Land Survey &
Establishing Reference, etc.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
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PART-A**

SECTION-I

**GUIDELINE
FOR
LAND SURVEY AND ESTABLISHING REFERENCE
GRIDS AND BENCH MARK PILLARS**

1.00.00 SCOPE

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutchha nullas, ditches, (with or without water), nearby roads / approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north, construction north and the angle between the grid lines (established at site) shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent / near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans / maps.

The Plot Plan gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased / decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the contractor and plotted in his maps / drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job

and handing them over to the Owner. It shall be responsibility of the contractor to check the pillars jointly with Owner / Engineer at the time of final handing over of the work to the Owner.

The contractor shall visit the project site, at their own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient knowledge about the site or for lack of clarifications on this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the contractor

2.01.01 Work to be provided by the contractor, unless specified otherwise, shall include but not be limited to the following:

- a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.
- b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.
- c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans / maps and drawings in specified scale incorporating sectional views and details as included under Section - 1.0.
- d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.02.00 Work to be provided for by others

No work under this specification shall be provided by any agency other than the contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Information to be Submitted by the contractor.

2.03.01 After Award

The contractor shall furnish to Owner the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that shall be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed which shall also include his present commitments.

The contractor shall inform and satisfy the Engineer regarding deployment of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner / Engineer and submit an agreed work programme and he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner / Engineer by the contractor progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with contractor's surveyor and engineer and point out the deficiencies / discrepancies, if any, therein. However, the contractor shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking / cross-checking as well as supervision during execution of the entire work, the contractor shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner / Engineer.

The contractor shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.00.00 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.01.00 Instruments

The entire field surveying shall be done with the combination of transit / optic Theodolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes, Total Station and Plane Table Survey by Clinometer with the help of Clinograph Scale, ranging rods, etc.

Theodolite shall be optically centered and the levels shall be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the contractor, shall be preferred.

3.02.00 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement: two coarse sand: four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and reference grids shall be of mild steel, conforming to IS: 2062.

4.00.00 EXECUTION

4.01.00 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner / Engineer.

4.02.00 Contour Intervals and Scale of Drawings

4.02.01 Contour Intervals

For contouring, spot levels shall be taken at 5 m horizontal intervals or less in both directions to establish the contours at 0.25 m intervals for nearly flat terrains and at 0.5 m intervals for undulating hilly terrains, as per the direction of the Owner / Engineer.

4.02.02 Scale of Drawings

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.03.00 Submission of Drawings and Documents

The following documents shall be submitted to the Owner / Engineer:

4.03.01 Original field & level books with notes taken on special features, plus a photo-copy each of the above documents.

4.03.02 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner / Engineer. (One copy shall be returned to the contractor with comments, if any).

4.03.03 Original and one (1) copy of the above field drawings (item 4.3.2 above) after field verification of the comments and incorporating the corrected features.

4.03.04 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing / map shall be as per direction of Owner /

Engineer.

4.04.00 Time of Completion

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. CI 4.03.00 above) shall be completed within a period in the following manner.

- a) Mobilization and firming up time schedule and survey groups... :
- b) Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.3.1 & 4.3.2 above). :
- c) Submission of the final survey maps & drawings and other documents (item 4.3.1, 4.3.3 & 4.3.4 above). :

The time schedule/period shall be as per L2 PERT and as mutually agreed by the contractor and owner.

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within weeks of the clearance from Owner / Engineer.

If the Owner / Engineer feel that the progress of the work is not satisfactory, he shall notify the contractor to take necessary measures to complete the Work on time. If the contractor fails to comply with the Owner's directive or fails to complete the Work on time, Owner shall be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money / Security Deposit of the contractor.

4.05.00 Security Rules and Statutory Regulations

The contractor shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment / instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The contractor, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner / Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The contractor shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The contractor shall give all notices and fees to be given or paid.

In respect of labour, the contractor shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The contractor shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the contractor shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.00.00 TECHNICAL SPECIFICATIONS

5.01.00 Establishing of Bench Marks

At least two permanent bench marks at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error shall not be more than ± 05 mm.

5.02.00 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100 m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.01. The maximum tolerance for any grid location shall be ± 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care shall be taken that no magnetic substance to influence the bearing reading is there. The magnetic north shall also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadastral map for establishing the new grid line and shall be related to true north line where grids do not exist.

5.03.00 Reference Grid Pillars and Bench Marks

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 150mm square x 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.04.00

Topographical Surveying and Mapping

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs / falls (if any) and other unusual ground formations / conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps:-

- a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.
- b) Levelling and plotting contours.
- c) Surveying and locating the natural, artificial and permanent features in details as described earlier.
- d) Taking of longitudinal and cross-sections of the corridors for pipe line and road / rail and drains, ditches, waterbodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.05.00

Traversing and Ground Controls

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points / features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner / Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object / reference grid pillar already existing at Site (as instructed by the Owner / Engineer).

The closing error in traverse (primary / secondary) shall not exceed one in three thousand in terms of length or, $L \sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.06.00

Contouring

Spot level surveying at specified intervals shall be adopted for contouring the



area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.07.00

Route Survey

Route Survey shall be conducted along a narrow strip / belt of the terrain selected after field reconnaissance or as directed by Owner / Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat / undulating terrains and at 20 m intervals in hilly terrains, as per direction of the owner / Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip / corridor shall be as specified in the drawing or as directed by Owner / Engineer.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION: II
GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-II
Geotechnical Investigation



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**VOLUME: II-G/2
PART-A**

SECTION: II

**GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION**

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The contractor shall perform all work under the purview of this specification along with all incidentals and related work including setting out, staging, approach to test locations, contractor's office, stores and protection of adjacent buildings, structures or services / facilities. No separate payments shall be made on such accounts. The contractor shall therefore take into account all such relevant items while quoting his bid. The boreholes shall be selected such that all the founding structures including RCC roads and Concrete pavements are represented.

2.01.00 Work to be provided for the contractor

The work to be provided by the contractor, unless specified otherwise shall include but not be limited to the following.

- a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervisions by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per contract terms, drawings, specifications and instruction of the owner / engineer.
- b) Locate in the field and in layout drawing all boreholes and other field investigation items.
- c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

- d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification and instructions of the owner / his engineer.

2.02.00 Work to be provided by others

No work under this specification shall be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Location and Levels

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the contractor at his own cost from two reference grids and one bench mark given by the owner/ his engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets / tables to be incorporated in the report by the contractor.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them up to the completion of the work shall be the responsibility of the contractor at no extra cost by the owner.

2.04.00 Codes and Standards

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

- | | | |
|---------|---|--|
| IS:1498 | - | Classification and identification of soils for General Engineering purposes. |
| IS:1888 | - | Method of load tests on soils |
| IS:1892 | - | Subsurface investigation for foundation |
| IS:1904 | - | Structural safety of buildings : shallow foundations |
| IS:2131 | - | Method for standard penetration test for soils |
| IS:2132 | - | Code of Practice for thin walled tube sampling of soils |
| IS:2720 | - | Methods of tests for soils |
| IS:2809 | - | Glossary of terms and symbols relating to Soil Engineering. |
| IS:2810 | - | Glossary of terms relating to soil dynamics |
| IS:3025 | - | Methods of sampling and testing for water used in industry |

IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for in-situ vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation
IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
IS:4968 (Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
IS:5529 (Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009 (Part-I)	-	Calculation of settlement of foundations - Shallow foundations subjected to symmetrical static vertical loads
(Part-II)	-	Deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks

IS:9143	-	Method for the determination of unconfined compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils
IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality
IS:2911 (Part I/Sec-1)	-	Code of practice for design and construction of pile foundations - Concrete piles/Driven cast in-situ concrete piles
IS:2911 (Part I/Sec-2)	-	Code of practice for design and construction of pile foundations - Concrete piles/Bored cast in-situ concrete Piles
IS:2911 (Part I/Sec-3)	-	Code of practice for design and construction of pile foundations - Concrete piles/Driven precast concrete piles
IS:2911 (Part I/Sec-4)	-	Code of practice for design and construction of pile foundations - Concrete piles/Bored precast concrete piles
IS:2911 (Part II)	-	Code of practice for design and construction of pile foundations - Timber piles
IS:2911 (Part III)	-	Code of practice for design and construction of pile foundations - Under-reamed piles

IS:2911 - Code of practice for design and construction of pile
(Part 4) foundations - Load test on piles

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the contractor at the locations which shall be marked by the contractor based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The borehole locations shall cover all the major structures/buildings under the scope of EPC package contractor.

Various methods of boring as described in IS: 1892 may be adopted. The contractor shall furnish the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata are not encountered, the boring shall be continued up to 30 m depth for two bore holes and up to 20m depth for the remaining boreholes unless stated otherwise. In case rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The contractor shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the contractor shall have no claim whatsoever on this score. If the contractor can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it shall be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it shall be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The contractor shall use his own materials for this and the scope shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall

be backfilled by the contractor using sand fill as and when directed by the Engineer.

3.02.00 **Stabilization of Boreholes**

Boreholes shall be stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.03.00 **Open Trial Pits**

The open trial pits shall be carried out by contractor at the locations which shall be marked by the contractor based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The contractor shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the engineer.

The contractor shall include the scope of trial pit with earthwork in excavation, necessary side slope, backfilling and shoring/ sheeting for side protection, if required.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.04.00 **NOT USED**

3.05.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation shall be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery shall be adopted for drilling through rock. The behavior of rock mass is governed more significantly by the nature of fractures in the rock than by the type and hardness of the material composing the rock itself. Hence, good drilling technique shall be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel,

the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring shall be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure shall be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid shall be introduced into the hole shall be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels shall be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the contractor shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the contractor shall determine nature of fractures and degree of weathering of rock for each bore hole. The contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stage of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The contractor shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer. All the field works shall be verified and signed by the Engineer (owner's) at site.

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is weathered, drilling must be continued up to 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the contractor shall also take into consideration the provisions of the latest revisions of the following Codes of Practice:

- a) IS: 6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).
- b) IS: 4078 - Code of Practice for indexing and storage of drill cores.

- c) IS: 4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.06.00 Adits and Test shafts

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for in-situ tests to determine the modulus of deformation of rock.

3.07.00 Sampling

Bored soil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring, since it is intended to ascertain the characteristics of the soil at various depths. If, however, there is fair uniformity in the characteristics of the soil for certain depths the engineer may limit the number of samples stipulated above.

3.07.01 Tube Sampling

For obtaining undisturbed samples in its simplest form, an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used shall have area ratio less than 13 percent and preferably less than 10 percent. The head shall have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling shall be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately one inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge or cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high, but not less than 50 mm dia. x 150 mm high.

Representative / disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.07.02

Chunk Samples

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.07.03

Sampling in rock

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed shall be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.08.00

Record of Boring

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and shall be submitted to the owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing shall be submitted with the soil report.

The field log shall contain at least the following information:

- a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.
- b) Personnel information - name of drilling contractor, driller and inspecting engineer.

- c) Equipment data - manufacturer's name and model designation.
- d) Sampling and coring information:
 - i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.
 - ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.
 - iii) Push samplers : hydraulic pressure and rate of penetration.
 - iv) Soil or rock coring : average rotational speed, down-ward hydraulic pressure and rate of penetration.
 - v) Rock coring : Rock quality designation (R Q D)
- e) Description of material penetrated but not sampled.
- f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.
- g) Seepage pressure test information-depth and duration of test.
- h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.
- i) Artesian pressure information - depth at which encountered, measured head and time at which each measurement is made.
- j) Elevation of top and bottom of hole and top of rock
- k) Date and time of all operations and delays with reasons.
- l) Miscellaneous information to aid interpretation of sub-surface conditions.
- m) Additional pertinent information.

The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log shall present a clear, concise and accurate picture of subsurface conditions to be utilized by the engineer.

4.00.00

PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00

Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the engineer. The contractor shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Hammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetrating shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00

Static Cone Penetration Test

The test shall be carried out by contractor at the locations which shall be marked by the contractor based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec approximately so as to advance the cone only to a depth which is possible with the cone assembly available.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The contractor shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00

Dynamic Cone Penetration Test

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentonite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part – II, the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5 mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs. depth.

5.00.00 GROUND WATER INVESTIGATION

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 Ground water level observation

The contractor shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations shall be taken by the contractor during the period of investigation. At the end of the site investigation work, these boreholes shall be handed over to the owner in such a condition that further observations can be taken by the owner for a period of at least a year.

Piezometers shall have to be installed in boreholes as directed by the owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station shall be used.

5.02.00 In-Situ Permeability Test

In-situ permeability test shall be performed in the boreholes specified and/or at such other locations at specified depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The contractor shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01

Pump - in Test

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of pre-bored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored / discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02

Pump - Out Test

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00

FIELD TESTS

In situ tests shall be performed as desired by the engineer to measure properties of soil during the field investigation work.

6.01.00

Menard Pressure meter test

This test shall be carried out as per clause 3.7 of IS:1892 in the bore holes specified and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The contractor shall submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The contractor shall also check and confirm whether the equipment he proposes to use shall be suitable for carrying out this test in bore holes of size specified under Clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00

Direct Load Tests on Soils

The direct load tests on soil shall be carried out in the trial pits specified and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm square plate shall be used in clayey soil and in sandy soils, three plates of size varying between 30 cm to 75 cm shall be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of sub-grade reaction and deformation modulus of soil.

The excavation and side protection during the test and back- filling after the test shall be carried out by the contractor. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of

dewatering shall be borne by the contractor.

The contractor shall submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The contractor must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level and staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the contractor shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

Each test shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m shall also be considered by the contractor if the site condition warrants. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement shall have to be provided by the contractor himself.

6.03.00

Vane Shear Tests

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00

Determination of Dry-Density of Soils

In place dry density of soil is required for assessment of bearing capacity of soils analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the engineer for determination of in-place dry density of soils.

6.04.01

Sand Replacement Method

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder shall be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder shall be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02

Core-cutter Method

The specification for this test shall be as per IS:2720 (Part XXIX). The method shall be applied for fine grained soil, free from aggregates. Fine grained soils for the purpose of application of this method are defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03

Ring and Water Replacement Method

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method shall be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04

Rubber balloon Method

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV). This method shall be applied for firmly bonded soils, it is unsuitable for very soft soils which shall deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00

In-situ Block Shear / Wedge Shear Test

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The test in the trial pits shall be carried out by contractor at the locations which shall be marked by the contractor based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The interpretation of test data and report shall be as per the provisions of IS: 7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

6.06.00

Test for Measurement of soil Resistivity

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing $S = 5, 10, 15, 20$ metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V , between the two inner electrodes is measured. The current I flowing into the earth produces an

electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity shall be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes, then the soil resistivity.

$$= 2 \times 3.14 \times S \cdot V / I$$

Where, Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

I = Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement, above formula becomes

$$= 2 \times 3.14 \times S \cdot R.$$

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than $1/20$ or the spacing between the electrodes.

Correction of the test results shall be done, if necessary, using the method outlined in IS: 3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The tri-axial test method using repeated static loading shall also be carried out for arriving at the value of the Young's Modulus.

The locations at which such tests are to be carried out as indicated and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.

The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The contractor shall submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its

adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The scope shall include earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 **Block Vibration Test**

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

- a) Vertical Vibration Test
- b) Longitudinal Horizontal Vibration Test
- c) Free Vertical Vibration Test
- d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS: 1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The contractor must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and

produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

The contractor shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the contractor shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the contractor shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00

FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

The test shall be carried out by contractor at the locations which shall be marked by the contractor based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The test shall be carried out at a depth of 500 mm below the finished ground level.

The contractor shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down in IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the

bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00

LABORATORY TESTS ON SOIL SAMPLES / ROCK CORES

The contractor shall carry out the tests as listed out and as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

Following laboratory tests shall be conducted: (preferably on Undisturbed soil samples and if UDS is not possible, on re-moulded soil samples)

- i) Grain size analysis
 - a) Hydrometer analysis
 - b) Sieve analysis
- ii) Field density and moisture content.
- iii) Specific gravity.
- iv) Chemical analysis of soil and ground water including sulphates, chlorides, pH value etc.
- v) Chemical analysis of 2:1, water:soil extract of the samples giving SO₃ content.
- vi) Consistency Index: Liquid limit, plastic limit, plasticity index, shrinkage ratio.
- vii) Consolidation test giving all relevant information.
- viii) Swelling pressure and free swell index for expansive soils.
- ix) Unconfined compressive strength on undisturbed soil samples
- x) Direct shear test.
- xi) Tri-axial compressive strength tests:
 - a) Unconsolidated undrained test
 - b) Consolidated undrained test
 - c) Consolidated drained test
- xii) Moisture density relations for Standard Proctor and Modified Proctor tests.

- xiii) Crushing strength, specific gravity, unit weight, water absorption test of rock specimens of NX size.
- xiv) Permeability test.

The owner shall have the right of access to contractor's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labelled and transported carefully to the approved laboratory for carrying out the tests. The method, number, type and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory-in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

10.01.00 General

- a) On completion of all the field (all the field works shall be certified by the owner) and laboratory work, the contractor shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the contractor shall submit ----- copies of the report in draft form for the owner's review.
- b) The contractor's qualified geotechnical engineer shall visit the owner's corporate office for a detailed discussion on the owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the contractor shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducibles of the graphs, tables, etc.
- c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The contractor shall

acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 **Data to be furnished**

The report shall include the enlisted items but not be limited to them.

- a) Purpose and scope of investigation
- b) Authorization enabling the contractor to carry out the work at the site.
- c) Project description including proposed facilities and construction materials required for the works.
- d) Description of the site which shall include :
 - i) Location of the site and existing facilities.
 - ii) Topography of the site
 - iii) Drainage Characteristics
- e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.
- f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.
- g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.
- h) Geological information
 - i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.
 - ii) Description of overburden and bedrock at the site (if applicable for the site)
 - iii) Comments on texture and structure of rock, joints, bedding planes, fissures, weathering condition etc (of applicable for the site)
 - iv) Effect of geologic features on design.
- i) Past observations and historical data, if available, for the area or for

other areas with similar profile or for similar structures in the nearby area.

- j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.
- k) Plot of SPT (N) value (both uncorrected and corrected) with depth.
- l) Procedure of investigations employed - field tests and laboratory investigation.
- m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.
- n) For all triaxial shear tests stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity E shall be furnished for all tests along with relevant calculations.
- o) For all consolidation tests, the following curves shall be furnished :
e vs. log p
e vs. p and

compression vs. log t or **Compression vs. square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).**

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

- p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.
- q) For pressure meter tests, the following curves shall be furnished :

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.
- r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00

Recommendations

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following:

- a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.
- b) For shallow foundations, the following shall be indicated with comprehensive supporting calculations:
 - i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.
 - ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.
 - iii) Rate and magnitude of settlement expected of the structure.
 - iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results along with time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.
- d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.
- e) Recommendations regarding bases of roads and pavements.

10.04.00

Additional Recommendations

- a) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.
- b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.
- c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

- d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.
- e) Co-efficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.
- f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.
- g) Recommendations regarding method and slope of deep excavations.
- h) Recommendations regarding stability of slopes, during excavations, etc.
- i) Potential of rock slides and methods of stabilisation of sides for very steep cut.
- j) If expansive soil is met with recommendation on removal or detainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.
- k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.
- l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.
- m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub- structures and also recommended protective measures, if required.
- n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.
- o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits / trenches.
- p) Recommendation on the use of rock available as construction material.
- q) Recommendation on the availability of material for use as aggregates at the site.



- r) Recommendation for additional investigation beyond the scope of the present work if the contractor considers it necessary.
- s) **Plates**
 - i) General plan showing location of site, and areal geology.
 - ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
 - iii) Geologic sections and soil profiles.
- t) **Appendices**
 - i) Logs of subsurface explorations
 - ii) Field test results
 - iii) Laboratory test results



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha**

**VOLUME: II-G/2
PART-A**

SECTION-III

**GUIDELINE
FOR
AREA GRADING**



Development Consultants Pvt. Ltd.

**Vol. II-G2/Part-A/Section-III
Area Grading**



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**VOLUME: II-G/2
PART-A**

SECTION-III

**GUIDELINE
FOR
AREA GRADING**

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, , hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for sub-grade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of areas within the power plant, disposing of unsuitable and excess excavated materials and incidentals thereof.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

Initial site leveling & Area Grading works of the entire plant area, raw water reservoir, and all other areas under EPC Package shall be carried out by contractor (refer Section A). Final micro leveling is to be done by the contractor as the area may get disturbed due to construction and monsoon activities.

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the followings:

- a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.
- b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of soils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.
- c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

2.02.00 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place,
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils,
IS : 3764	:	Safety Code for Excavation Work
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work

2.04.00 **Conformity with Designs**

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Owner.

2.05.02 Borrow Material

Borrow material if required for area filling shall be excavated from approved locations and levels within a lead of 20Km, and shall consist of selected material, approved by the Owner, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage.

Necessary arrangement shall be done by the Contractor for locating and using the borrow areas after approval as the source of supply of filling material.

The depth of borrow pits shall be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

- a) Lines, Levels and Grades:
 - i) Periodic Surveys
 - ii) Establishment of markers, Boards etc.
 - iii) Checking levels and slopes of the graded surface.
- b) Area filling :
 - i) Checking the quality of fill material
 - ii) Checking moisture content of the

fill.

- iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications shall be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection shall be reviewed in accordance with the site Quality Plan.

3.00.00 EXECUTION

3.01.00 General

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the Contractor. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Owner. Adequate area lighting shall be provided by the Contractor, if night work is undertaken.

The Contractor shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Owner. The proposal shall include but not be limited to the following.

- a) Mobilization and demobilization of plant
- b) Proposed plant and equipment, labour resources & supervision.
- c) Details of proposed method of clearing and grubbing for each area of cut and fill.
- d) Drawings showing the areas for placement of material.
- e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.
- f) Temporary works proposals
- g) Excavation, filling and compaction by mechanical plant

- h) Dealing with surface water
- i) Dewatering
- j) Disposal of materials
- k) Safety precautions, fencing and lighting
- l) Calculations as appropriate to support work proposal

3.02.00 Setting Out

The Contractor shall prepare and submit to the Owner/Consultant, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Owner/Consultant with modifications and corrections if necessary, the Contractor shall set out the work from the control points furnished by the Owner and fix permanent points and markers for future checking. These permanent points and markers shall be checked by the Owner and certified by him after which the Contractor shall proceed with the work. It shall be noted that this checking by the Owner prior to start of the work shall in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor.

3.03.00 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Owner shall be taken by the Contractor jointly with the Owner over the original ground prior to starting actual grading work and after setting out. These initial levels and cross-sections shall be jointly signed by the Contractor and the Owner before commencement of work.

3.04.00 Clearing and Grubbing etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. if any and leveled up.

Before grading is started, all the spoils and unserviceable materials and rubbish shall be removed from the site to approved disposal areas within a lead of 5Km as specified. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner. Disposal shall be carried out as per cl 3.08.02 of this volume

3.05.00 Classification

Materials involved in grading shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor:

a) **Ordinary and hard soil**

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) **Soft and Decomposed Rock**

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction.

c) **Hard Rock**

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork.

3.06.00 **Earthwork in Excavation**

3.06.01 **General**

Before commencement of excavation/filling the existing ground surface shall be cleared in accordance with Clause no. 3.4.0.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even below the final level and the same shall be filled with suitable filling materials as directed by the owner/consultant and well compacted.

3.06.02 **Excavation in Ordinary Soil, Hard Soil & Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines, drains, trenches etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation.

On completion, the work shall be finally checked and approved by the Owner. Further work shall be resumed after getting clearance from the Owner.

3.06.03 **Excavation in Hard Rock**

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

Controlled blasting shall be permitted as applicable with necessary statutory approval to be obtained by EPC contractor as required. The excavation shall be carried out by chiseling, wedging with pneumatic equipments or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc.

3.06.04 NOT USED

3.06.05

Disposal

The excavated spoils shall be disposed off within the specified lead of 5Km in any or a combination of some of the following manners, as directed by the Owner :

- a) By stacking separately the materials suitable for area filling and materials not suitable.
- b) By stacking it temporarily for use in backfilling at a later date.
- c)
 - i) by either spreading, or
 - ii) Spreading and compacting at designated filling areas and/or disposal areas.

Disposal shall be carried out as per cl 3.08.02 of this volume

3.06.06

Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Owner, any water inclusive of rain water and subsoil water accumulated in the area. Method of dewatering shall be got approved by the Owner.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.06.07

Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may

need to construct temporary drainage systems to drain surface water from working areas.

3.07.00 Treatment of Slips

The Contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water shall cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him.

3.08.00 Earthwork in Filling

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Owner, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated soils or from borrow pits in selected areas designated/approved by the Owner. The quality of the material shall conform to that mentioned in clause 2.05.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murmur or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Owner, Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited / disposed of as directed by the Owner within a lead of 5 KM after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Owner.

Before commencement of area filling the existing top soil shall be removed up to a minimum depth of 150 mm, or more, as directed by the Owner in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 300 mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Owner.

- a) Each layer of earth of cohesive in nature shall be compacted to 90% of proctor's dry density unless otherwise permitted /directed by the Owner.
- b) Each layer of earth of non-cohesive in nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Owner. Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be

allowed unless specifically permitted by the Owner.

The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tons roller.

- i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.
- ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimize the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Owner and shall conform to the stipulations laid down in IS:4701.

The cohesion-less soil to be used for area filling, shall be placed in fully saturated condition to obtain the maximum possible density. The saturation moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the Contractor's cost as directed by the Owner. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the Contractor's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill shall be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cm approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling and any waste material, shall be disposed of in designated disposal areas within a lead of 5KM as directed by the Engineer-in-charge. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 300mm in thickness and nominal compaction done upto 85% Proctor density to the satisfaction of the Owner.

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers, rollers and trucks shall be allowed to ply over the fill to permit compaction to take place.

3.09.00 Compaction Control

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Contractor in accordance with these specifications and as directed by the Owner.

The Contractor shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Contractor is to obtain the Owner's approval for the firm to be used. The Contractor may undertake this work with the Owner's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Owner based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The Contractor shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Owner.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

Tests shall be undertaken by the Contractor as per IS 2720 and as required by the owner. The results and reports shall be submitted to the Owner/consultant for approval. Test failures are to be immediately notified to the Owner/consultant, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction.

Each layer is to be tested in a manner that is representative of its full depth. The Owner/consultant may at his discretion instruct the Contractor to increase or decrease the frequency of testing.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area shall be checked as per the drawings after the area is completely dewatered. The work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by selective materials. Over excavation of the sides shall be made good by the Contractor. The excavation work shall be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed

4.02.02 Area-filling

The degree of compaction required shall be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved shall be as decided by the Owner. The work of area filling shall be accepted after the Owner is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted before starting the work.

- i) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.
- ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.
- iii) Method of transportation.

After award of contract the Contractor shall submit the following for approval and adoption :

- a) The Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme shall also show how the excavation and area-filling quantities shall be balanced, minimising temporary stacking of spoils.

It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor shall have sufficient flexibility to take care of such reasonable variations.

- b) The Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Owner/Consultant for adoption.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION-IV
GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-IV
Earthwork in Excavation & Backfilling



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PART-A**

SECTION - IV

**GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor of EPC Package, unless specified otherwise, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.
- b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Owner.
- c) To carry out sampling and testing and submit to the Owner, results of soil compaction tests whenever required by the Owner to assess the degree of compaction.

2.02.00 Work to be provided for by others

No work under this specification shall be provided by any agency other than the Contractor of EPC Package unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision (as on the original scheduled date of Bid opening) and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Owner /Consultant shall be followed :-

IS:2720 (Part-II)	Determination of Moisture Content
IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.
IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.
IS:2720 (Part-xxix)	Determination of Dry Density , in place, by core cutter method.
IS:2720 (Part- xxviii)	Determination of Dry Density of soils, in place, by sand replacement methods.
IS:3764	Safety code for Excavation work.
IS:4701	Earthwork on canals

2.04.00 Conformity with Designs

Contractor of EPC Package is to carry out the work as per the drawings which are approved by the Consultant and/or the Owner's instructions.

2.05.00 Materials to be used

2.05.01 General

All materials required for the work shall be of best commercial variety and approved by the Owner.

2.05.02 Borrow Material

Borrow material if required for back-filling shall be excavated from approved locations and levels (within a lead of 20KM), and shall consist of material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material without any additional cost to owner.

2.06.00 Quality Control



The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

- a) Lines, Levels and Grades:
 - i) Periodic surveys
 - ii) Establishment of markers, boards etc.
- b) Back-filling :
 - i) Checking the quality of fill material
 - ii) Checking moisture content of the backfill
 - iii) Checking the degree of compaction

2.07.00 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered by visiting site before bid submission and doing soil testing if necessary.. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution

3.00.00 EXECUTION

3.01.00 Setting Out

Contractor shall prepare and submit to the Owner / Consultant, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Owner/Consultant with modifications and corrections, if necessary, the Contractor shall set out the work from the control points furnished by the Owner and fix permanent points and markers for ease of future checking.

These permanent points and markers shall be fixed at intervals prescribed by the Owner and checked by the Owner and certified by him after which the Contractor shall proceed with the work. It shall be noted that this checking by the Owner prior to start of the work shall in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Contractor's work at any stage.

3.02.00 **Initial Levels**

Initial levels either in a definite grid pattern or as directed by the Owner will be taken by the Contractor jointly with the Owner over the original ground prior to starting actual excavation work and after setting out. These initial levels and cross-sections shall be jointly signed by the Contractor and the Owner before commencement of work.

3.03.00 **Clearing and Grubbing, etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be removed from the site to approved disposal areas within a lead of 5KM as may be specified. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner. Disposal of waste/surplus material shall be carried out as per cl 3.05.06 of this volume

3.04.00 **Classification**

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include:

- i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
- ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
- iii) soling of roads, paths, etc., and hard core ;

- iv) macadam surfaces such as water bound, and bitumen/tar bound;
- v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
- vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
- vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include:

- i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
- ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
- iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
- iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (blasting prohibited)**

This shall include:

- i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required;
- ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
- iii) boulders requiring blasting.

Hard rock as described above the excavation has to be carried out by chiseling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 **Excavation for Foundations and Trenches**

3.05.01 **General**

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Owner. The vertical faces of excavation shall not be undercut for extended footings / foundations. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Owner they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Owner /Consultant and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Owner, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Owner, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Owner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Owner (with lean PCC M10).

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Owner, due to the Contractor's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than M10 concrete or richer) as directed by the Owner in each individual case.

If the bottom of any excavation at design depth appears to be soft, unsound or unstable, the Contractor shall report the matter to the Owner and if the Owner so directs, shall excavate the same to indicated depths. The extra depth shall be filled up with concrete M10 or such other material as the Owner shall direct.

In formation of rock requiring blasting, those overcuts which are unavoidable shall be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Owner and shall be the property of the Owner.

3.05.02 **Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workman like manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall be finally checked and approved by the Owner. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Owner may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

For Hard rock, the excavation shall be carried out by chiseling, wedging or any other approved method.

Note: Extra claim shall not be permitted for difficulties facing in any type of earthwork

3.05.04 NOT USED

3.05.05 **Disposal**

The excavated spoils shall be disposed of in any or all the following manners:

- a) By using it for backfilling straightway.
- b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.
- c)
 - i) By either spreading or
 - ii) Spreading and compacting at designated filling areas and / or disposal areas.
- d) By selecting the useful material and stacking it neatly in areas designated by the Owner.

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area within a lead of 5KM selected by the Owner without any additional cost to owner. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 300mm in thickness and nominal compaction done upto 85% Proctor dry density to the satisfaction of the Owner

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers, rollers and trucks shall be allowed to ply over the fill to permit compaction to take place

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.05.07 **Protection**

The Owner shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Owner, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval by the Owner. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench

or half the depth of the pit or trench whichever is more or further away if directed by the Owner.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean. The use of mechanical equipment shall not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. The existing facilities shall be retained either by modifying or relocating as the case may be without any additional cost to owner.

3.05.08 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.05.09 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Owner any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Owner but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain. Contractor has to deploy dewatering

diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.05.10 **Timber Shoring**

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Owner. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Owner. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacing, cross struted with ballies or as directed by the Owner. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be struted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and shall proceed systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Owner. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**



The Contractor shall take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water shall cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed and back-filled later by him without any additional cost to the Owner.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Owner obtained directly from areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Owner. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Owner may direct sand fillings if required. The sand shall be clean, well graded and be of quality normally acceptable for use in concrete. No extra cost shall be claimed by the contractor on account of this.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Owner. Compaction of the structure backfill by inundation with water shall not be permitted. The final surface shall be trimmed and leveled to proper profile as shown in the drawing and as desired by the Owner.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on it and corrections done to optimize the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Owner. When the filling reaches the finished level, the surface shall be

flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings or as specified elsewhere in the specification.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling up to a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 **Filling in Disposal Area**

Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within a lead of 5KM. The spoils shall not be dumped haphazardly but shall be spread in layers approximately 300mm thick when loose and compacted with the help of compacting equipment upto 85% Procter's dry density and compaction done to the satisfaction of the Owner at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Owner may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00

Approaches and Fencing



The Contractor shall provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits shall be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 **Lighting**

Full scale area lighting is to be provided by the contractor if night work is permitted or directed by the Owner. If no night work is in progress, red warning lights shall be provided by the contractor at the corners of the excavated pit and the edges of the fill.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **Excavation**

On completion of excavation, the dimensions of the pits shall be checked as per the drawings after the pits are completely dewatered the work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of M10 proportion and/or richer, as directed by the Owner / Consultant.

Over excavation of the sides shall be made good by the Contractor while carrying out the back-filling.

The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 **Back-filling**

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part - VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling shall be accepted after the Owner is satisfied with the degree of compaction achieved. Owner may direct for sand filling if compaction not achievable in some cases based on detailed engineering requirement

5.00.00 **INFORMATION TO BE SUBMITTED**





5.01.00 Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted to the Owner before commencing the work.

5.02.00 **After Award of Contract**

After award of the Contract the Contractor shall submit the following for approval and adoption:

- a) Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme shall show how the excavation and back-filling quantities shall be balanced, minimising temporary stacking of soils. It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor shall have sufficient flexibility to take care of such reasonable variations.

- b) The Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Owner /Consultant for adoption.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A**

SECTION-V

**GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-V
Bored Cast in Situ Concrete Pile



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

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**VOLUME: II-B
SECTION: I**

PART: A

SUB SECTION: V

**GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE**

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast- in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2), Latest Revision shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

Bored Cast-in-situ RCC pile passing through top soil overburden and terminating in the underlying weathered rock with a socket length not less than $3D$, (where D is the diameter of the pile) within such layer, will be considered. The capacity of the pile will be confirmed by the contractor by necessary load testing as per BIS and by design calculations.

To get generalized & tentative idea of sub-surface stratification as a whole, the soil report available with purchaser may be studied. However a confirmatory soil investigation will be done by the contractor before award of contract if required and after award of work to ascertain the top level of rock layer for their internal assessment of Pile length only. This will in no way affect the pile parameters stipulated in this specification.

2.00.00 GENERAL

2.01.00 Work to be provided by the contractor

The work to be provided for by the contractor, unless otherwise specified, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.
- b) Mark the proposed sequence of installation on six (6) copies of

identification plan. The identification plan will be prepared by the contractor as per the basic plan furnished by the Engineer, if so desired by him.

- c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.
- d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.
- e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.
- f) Make necessary earthwork and approaches for movement of pile installation equipment.
- g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specified elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

- IS : 8112 - Indian Standard Specifications for 43 Grade Ordinary Portland Cement.
- IS : 12269 - Indian Standard Specifications for 53 Grade Ordinary Portland Cement.
- IS : 383 - Indian Standard Specifications for Natural Sources for Concrete.
- IS : 432 - Indian Standard Specification for (Part - I) Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.
- IS : 455 - Indian Standard Specifications for Portland Slag Cement.
- IS : 456 - Indian Standard Code of Practice for Plain and

Reinforced Concrete.

- | | | |
|-----------|---|--|
| IS : 516 | - | Indian Standard Specifications for Methods of Test for Strength of Concrete. |
| IS : 1199 | - | Indian Standard Specifications for Methods of Sampling and Analysis of Concrete. |
| IS : 1786 | - | Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement. |
| IS : 2062 | - | Steel for General Structural Purposes |
| IS : 2386 | - | Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII. |
| IS : 2502 | - | Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement. |
| IS : 2722 | - | Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type). |
| IS : 2751 | - | Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction. |
| IS : 2911 | - | Code of Practice for Design and Construction of Pile Foundations - Bored Cast-in-situ piles. (Part-I/Sec.2) |
| IS : 2911 | - | Code of Practice for Design and (Part - IV) Construction of Pile Foundations - Load Test on Piles. |
| IS : 4926 | - | Indian Standard Specifications for Ready Mixed Concrete. |
| IS : 9716 | - | Guide for Lateral Dynamic Load Test on Piles. |

2.04.00 Conformity with design

The contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 Materials

2.05.01 General

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 Casing

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 Concrete

Concrete type M30 min grade shall be used for piles. Materials and method of manufacture for cement concrete shall in general be in accordance with IS: 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS: 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Contractor at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. The water-cement ratio shall not exceed 0.5. To achieve the specified slump using specified water cement ratio without compromising with strength, suitable plasticiser, if required, may be used at no extra cost, subject to approval of Owner. If concentration of Sulphate (measured as SO_3) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement shall be used. The minimum cement content should be 400 for M30 grade concrete respectively based on subsoil condition requirement besides that required from strength and other considerations.

The physical properties, mechanical properties & gradation of coarse & fine aggregate shall follow IS:383. Testing of aggregate properties (if desired by purchaser) shall follow relevant parts of IS:2386.

Refer General Specification for civil work for construction water.

Preliminary mix design shall be done in accordance with IS:10262 & SP:23 subject to approval of OWNER. Cube tests, slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at site / site laboratory at contractor's own cost. Concrete cube tests shall be done as per IS: 516. The calibration certificate (not older than one year) of the testing machine.

The calibration certificate (not older than one year) of the testing machine shall be available at site. If purchaser feels any doubt about the calibration,

the contractor shall get it checked at an approved laboratory at his own cost. All such tests shall be conducted in presence of purchaser. At least one set (3 cubes for 7 days & 3 for 28 days strength) of cube shall be tested for every 10 piles or at any deterioration in concrete quality if felt purchaser, whichever occurs earlier. Slump tests (apparatus conforming to IS:IS:7320) shall be carried out at least once for each pile or more frequently, if desired by purchaser.

2.05.04 Reinforcement

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786. All bars shall be Corrosion Resistant Steel(CRS). Test certificate for reinforcement steel shall be obtained from recognised agency, before using. The purchaser may desire to check the testing of the same and the contractor shall arrange it in an approved laboratory at his own cost.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 Casing

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 Quality Control

The contractor shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

- a) Location and plumb : Control survey for accuracy in plan and check for verticality.

- b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.
- c) Boring : Boring method to suit soil profile.
- d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.
- e) Inspection of pile
- f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a 'non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS : 2911 (Part - I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The contractor shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the contractor bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The contractor will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable continuous hard strata based on approved soil data. In case the contractor is required to drive piles to greater or shallower depths than that is envisaged, no other extra claims will be entertained. The contractor should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

IS:2911 (Part 1/Section 2) : 'Code of practice for design & construction of Bored Cast-in-Situ concrete piles', IS : 2911 (part 4) 'Load Test on Piles & IS : 14593 : 'Design And Construction of Bored Cast-in-situ Piles founded on Rocks – Guidelines' will be referred to in conjunction with this specification during the entire design, construction & Load Testing work. These code form the integral part of this specification.

The piles will be bored cast-in-situ cylindrical type RCC piles of 450 mm &/or 550 mm &/or 750 mm &/or 1000 mm dia terminated within underlying sand stone layer with a rock-socket length not less than 3D (where D is the diameter of the pile) , to achieve the design capacity. Minimum center to center spacing between adjacent piles will be 2.5 D.

Sub-surface profile & Level of weathered Rock layer in different locations of the site are furnished in the Soil Investigation report available with purchaser .

The contractor will submit the structural design of pile for approval of purchaser/consultant . The contractor will guarantee the minimum safe vertical compressive design load capacities for piles

Capacity of Single Pile

A) Vertical Compressive capacity

The contractor will submit capacity of piles diameter wise along with design requirement .

B) Uplift Capacity

The Uplift capacity (for tension pile only) of single pile (with 3D rock socket), at this site, will be considered as 25 % of their respective Compressive capacity plus buoyant weight of pile. However, the same has to be confirmed by the successful contractor, by field load test on Trial pile before taking up the working piles.

C) Lateral Capacity

The Lateral capacity of single pile, at this site, will be considered as the minimum of the following:-

- i) 5 % of their respective compressive capacity of pile.
- ii) Lateral pile capacity assessed by the successful contractor by initial Pile Load Test on Trial Pile at selected representative locations, before taking up working piles. At least 3 Nos. of such tests is

necessary, locations for which will be mutually decided by the contractor & purchaser.

The contractor shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., quality, workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Contractor with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Contractor to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length with no extra cost to Owner for deviation in length above or below the stipulated basic length.

The load test must be satisfactory and accepted by the Engineer. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the test shall be repeated to the satisfaction of the engineer without any extra cost.

3.03.00 Identification of Piles

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 Sequence of Piling

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity reduced by subsequent boring/driving operation. The Contractor shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 Boring

3.05.01 With Casing

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Contractor based on visual inspection of recognizable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Contractor to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Contractor on such pro- portion of the heaved piles which shall be ordered by the Engineer.

3.05.02 With Drilling Fluid

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in inter- mediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 Spacing of Piles

In general, all piles shall have a minimum spacing on centres of $2.5d$ (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 Placing of Reinforcement

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 Concreting

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilized and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 Tremie Method of Concreting

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

- a) The concrete shall be coherent, rich in cement (not less than 400 kg/m³) and of slump not less than 100 mm.
- b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.
- c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.
- d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.
- e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.
- f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the laitance from being entrapped within the pile.
- g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laitance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A ver- miculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 Concreting in Cased Holes

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 Cut-off Level

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 600 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 Steel Pipe or Casing tube

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Contractor's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days.

The concreted length of piles shall be measured from the toe of pile to cutoff level of pile.

Boring of any pile shall not be carried out within a clear distance of three times of the pile diameter from the adjacent pile which has been freshly concreted within past 24 hours.

The contractor shall take all necessary actions to prevent side collapse (if any) of pile bore at his own cost.

The contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places as indicated by purchaser. The cost of such disposal shall be deemed to have been included in the rate of piling.

Founding Strata

All the piles shall be founded on approved bearing strata or upto specified depth as per design requirement & as mentioned in the drawing.

In general, criteria for approval of founding strata shall be agreed between purchaser & contractor based on visual identification of recognisable samples recovered from pile borehole & specified SPT criteria.

In case, pile is socketted in rock strata, a minimum socketted length of Thrice the pile diameter (3D) shall be provided. The founding rock strata shall be identified by recognisable rock piece sample obtained by boring tool from pile bore &/or wash of rock powder in return water, SPT N > 100 at termination level and as decided by purchaser.

Termination criteria may be standardised / modified at site by purchaser depending on actual sub-surface material encountered and rate of penetration through such strata with the available equipment & accessories.

3.11.00 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 Removal of Spoil

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the Scope.

3.13.00 Back-Filling of Abandoned Borings

The Contractor shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix M10 so that resistance to lateral forces on neighbouring piles are developed.

3.14.00 Record for Installation of Piles

The Engineer and the Contractor shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Contractor. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

- a) Date of completion, pile number & sequence of installation of piles in a group.
- b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.
- c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.
- d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.
- e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.
- f) Method of cleaning bottom of hole at founding level before concreting.
- g) Records of additional borings or other subsurface information obtained during the process of boring.
- h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Contractor. These data along with the load-displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 Defective Piles

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified, such piles may be deemed to be defective and the Engineer may order such investigation

to be made as he considers appropriate.

When any pile is found defective, the Contractor shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

- i) Replacement of defective piles.
- ii) Providing additional piles.
- iii) Alteration in design of pile caps.

3.16.00 Idle Period

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the contractor will not be entitled to any claim due to this reason.

3.17.00 Test Pile

The contractor may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part - IV) or as directed by the engineer.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of RCC

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 Components of Steel

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 Load Tests

4.04.01 General

Initial tests and/or routine tests as indicated in the FQP or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the tests described below shall be carried out as indicated in the FQP or as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 Vertical Load Test [as per IS : 2911 (Part-IV)]

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified in latest version of IS 2911 (Part-IV).

4.04.03 Lateral Load Test

The test shall be carried out as per IS 2911 (Part 4) latest version for safe loading criteria..

4.04.04 Pull-out Test

The test shall be carried out as per IS 2911 (Part 4) latest version for safe loading criteria.

4.05.00 Non-destructive Dynamic Test on Working Piles

4.05.01 "Low Strain" Method for Integrity Investigation of Concrete Piles :

The method of testing shall conform to ASTM D 4945 or equivalent Indian Standards.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 "High Strain" Method for Determining of Pile Capacity

The method of testing shall conform to ASTM D 4945 or equivalent Indian Standards.

All equipment including piezoelectric transducers, strain gauges, pile driving

analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the contractor. For every hammer below, the analyser shall determine the following data :

- i) Pile bearing capacity
- ii) Transferred energy
- iii) Maximum compression force
- iv) Maximum tension force
- v) Maximum impact velocity
- vi) Maximum acceleration
- vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 Acceptance Criteria

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

- a) The head of the pile shall be within 75 mm of the specified position on the drawings.
- b) The pile shall not be out of plumb by more than two percent.
- c) The toe of the pile shall be at the approved bearing level in each case.
- d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.
- e) The results of the load tests incl. non- destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.
- f) In case of single pile the positional tolerance shall not be more than 50 mm.

4.07.00 Lateral Dynamic Load Test on Piles

Two types of tests, namely, free and forced vibration lateral tests shall be

carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

- i) Frequency of vibrations
- ii) Amplitude of vibrations
- iii) Imparted dynamic force
- iv) Natural frequency
- v) Damping coefficient
- vi) Soil-pile stiffness
- vii) Coefficient of horizontal soil modulus variation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.01 Design Data

The contractor shall submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 Programme of Construction

The contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up, keeping in view the completion dates stipulated in the contract.



5.02.00 After Award

After award of the contract, the contractor is to submit the following details :

5.02.01 Execution Plan

The contractor will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 Detailed Construction Programme

A detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the contractor is to supply as per the terms and conditions of contract is to be submitted.

5.02.04 Test Results

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION-VI
GUIDELINE
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-VI
Cement Concrete (Plain & Reinforced)



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Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-VI
Cement Concrete (Plain & Reinforced)

**VOLUME: II-G/2
PART-A**

SECTION-VI

**GUIDELINE
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)**

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or pre-cast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Consultant shall be followed. All codes and Standards shall conform to its latest revisions as on the original scheduled date of Tender opening. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor.

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following :-

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.
- c) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

- d) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.
- e) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- f) Design and submit for approval concrete mix designs required to be adopted on the job.
- g) Furnish samples and submit for approval results of tests of various properties of the following :
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

2.02.00 Work by Others

No work under this specification shall be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Contractor

2.03.01 After Award of the Contract

The following technical information shall be furnished after award :

- a) Source and arrangement of processing of aggregates proposed to be adopted.
- b) Type of plant and equipment proposed to be used.
- c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02 The following information and data including samples where necessary shall

be submitted by the Contractor progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Owner/Owner's Consultant depending on the exigencies of the work.

Detailed day to day programme of every month shall be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Owner, in sufficient quantities for approval. Approved samples shall be preserved by the Owner for future reference. The approval of the Owner shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :

- i) Coarse and fine aggregates
- ii) Admixtures
- iii) Plywood for Formwork
- iv) Embedded and anchorage materials as may be desired by the Owner /Consultant.
- v) Joint sealing strips and other waterproofing materials.
- vi) Joint filling compounds
- vii) Foundation quality Rubber Pads

c) Design Mix

Design mix as per Clauses 2.01 (f) & 3.04 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., shall be submitted to the Owner/Consultant for his approval before it can be used on the works.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b).

- e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (b).
- f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (d).
- g) Mill Test Reports for Cement & Reinforcing Steel
- h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Owner /Consultant in accordance with Clause 2.04 of this specification.
- i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.
- j) Any other data which may be required as per this specification.

2.04.00 Conformity with Design

The Contractor shall prepare check lists in approved proforma which shall be called 'Pour Cards'. These Pour Cards shall list out all items of work involved. The Contractor shall inform the Owner/Consultant, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Owner/ Consultant for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Owner /Consultant shall give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Owner /Consultant and the records of compliance by the Contractor, deviations allowed by the Owner /Consultant and any other relevant information shall be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', shall be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments shall be handed over to the Owner/Consultant before starting placement of concrete.

One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Owner /Consultant by trial mixes shall be permitted to be used by the Owner /Consultant, the choice being dictated by the requirements of designs and workability.

The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete shall be as approved or directed by the

Owner /Consultant.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials for the construction shall conform to the relevant IS Code unless stated otherwise and be of best approved quality.

2.05.02 Cement

Generally cement shall be 43 grade ordinary Portland / slag Cement conforming to IS-269 . In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Owner /Consultant :

- a) 53 Grade ordinary Portland Cement conforming to IS-269
- b) Rapid hardening Portland Cement conforming to IS-8041
- c) Portland slag cement conforming to IS-455
- d) Hydrophobic Cement conforming to IS-8043
- e) Low heat Portland Cement conforming to IS : 12600
- f) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 Aggregates

Aggregates shall be natural or crushed stone or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Owner /Consultant.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 shall be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Owner /Consultant may ask the Contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 (latest revision) is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works. Normally river sand shall be used as fine aggregates.

In case of unavailability of normal specified river sand, the M sand (Crushed stone sand) conforming to Zone 2 shall also be permitted as per given criteria/specifications below. Approval shall be obtained from NLCIL Site in- charge for source of M-sand.

- i) As per Cl. 3.1.4 , of IS-383 (latest revision) the terminology of M-sand (manufactured sand) as defined as fine aggregate manufactured from other than natural sources , by processing materials using thermal or other processes such as separation, washing, crushing and scrubbing. Generally the M sand or Crushed stone sand for the fine aggregate are produced by crushing the hard stone.

The Crushed stone sand or M sand conforming to the following shall only be used as fine aggregate in making concrete for sub and superstructures.

The Crushed stone sand is to be manufactured using VSI crushers only and not with HSI crushers. In order to remove the fines , Crushed stone sand manufacturer shall have mechanized washing facility unit. Crushed sand stone conforming to Grading zone –II as per IS-383 (latest rev.) shall only be used. The M sand shall comply all the parameters and recommendations of IS: 383 (latest rev.)

- ii) The M sand shall be used only after the following tests are to be conducted by the contractor at the NABL accredited laboratories with proven track records of performing such type of tests by sending sealed samples of the materials –

- a) Gradation Test.
- b) Petrography.
- c) Silt content.
- d) Permeability test.
- e) Adulteration test.
- f) Design Mix Report.
- g) Chemical Analysis Report

Using of M-Sand/Crushed Stone Sand based on the Test reports shall only be done after written approval of Engineer-In-Charge.

- iii) In the structures where the slip for construction is envisaged, M sand or Crushed stone sand may be used to meet the design requirements for slip form with all special precautions like use of construction chemicals and other admixtures to avoid dragging issues
- iv) Special care for design mix, cement content and necessary curing in the initial stage shall be taken care of while using M sand /Crushed stone sand. However if the results are not satisfactory , the use of crushed stone sand shall not be allowed for all RCC floor slab upto and including 150 mm thickness, which are directly exposed to the atmosphere immediately after casting. In such cases the ordinary river sand shall be used.
- v) The M sand/Crushed stone sand manufacturing locations shall be inspected by the Owner before giving approval for supply. The contractor shall ensure that the manufacturing process is done using only VSI crushers & shall have mechanized water washing unit for removal of fines in the Crushed stone sand manufactured.

Aggregates smaller than 4.75 mm and within the grading limits and other requirements set in IS-383 (latest rev.) termed as fine aggregate. Only fine aggregate from approved sources and conforming to IS- 383 (latest rev.) shall be used for execution. The contractor shall have well developed site laboratory and quality control team to take extra care while manufacturing and casting concrete using M sand/ Crushed stone sand.

Normally, any particular structure shall be constructed by using any one type of sand (fine aggregate) only as per the direction / approval of engineer-in-charge. In general, it is not permitted to use different types of sand in any particular structure. However, type of Sand in foundation may be different from the type of sand for the rest of the structure.

2.05.04 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 shall be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-1 of IS:456.

In case of doubt regarding development of strength , the suitability of water for making concrete shall be ascertained by compressive strength and initial

setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 Admixture

Only admixture of approved quality shall be used when directed or permitted by the Owner /Consultant. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

- IS : 2645 - Integral cement water proofing compound
- IS : 9103 - Indian standard specification for Admixtures for Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075 , Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or equivalent.

b) Retarding admixtures :

Modified ligno sulphonate based set retarding concrete admixture like , "Plastiment R" or equivalent.

c) Water reducing admixtures :

Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or equivalent.

d) Air entraining admixtures :

Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER" or equivalent.

e) Water proofing admixtures

All water retaining structures shall be provided with water proofing admixtures

- Modified ligno-sulphonate based waterproofing admixture like "Plastocrete Super" or equivalent.

However, the Contractor shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the

approval of the Owner/Consultant :

- i) Type of admixture
- ii) Mix proportion & mode of application in concrete/mortar
- iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content , PH value infra-red analysis & solid content.)

2.05.06 Reinforcement

Reinforcement shall be Corrosion Resistant Steel (CRS) of Fe 500/500D/550 grade and as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. Higher grade steel may also be used; however the design shall be restricted to Fe500 for Flexural Design and Fe415 for Shear design. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Owner /Consultant, shall not be used for concrete and shall be removed from site immediately, failing which, the Owner /Consultant shall be at liberty to get the materials removed and Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Owner/Consultant.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Owner /Consultant, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Owner.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Owner. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Owner/Consultant to assure compliance with contract requirements and maintain and submit to the Owner/Consultant records of the same.

The quality control operation shall include but not be limited to the following items of work :

- | | | | |
|----|---------------|---|---|
| a) | Admixture | : | Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits |
| b) | Aggregate | : | Physical, chemical and mineralogical qualities. Grading, moisture content and impurities. |
| c) | Water | : | Impurities tests. |
| d) | Cement | : | Tests to satisfy relevant IS Specifications |
| e) | Formwork | : | Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating. |
| f) | Reinforcement | : | Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. |

- Material tests or certificates to satisfy relevant IS Specification
- g) Grades of concrete : Usage and mix design, testing of all properties.
 - h) Batching & Mixing : Types and capacity of plant, concrete mixers and transportation equipment.
 - i) Joints : Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
 - j) Embedded and Anchorage Items : Material, shape, location, setting.
 - k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
 - l) Compaction : Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
 - m) Setting of base & Beaming Plates : Lines, elevations and bedding mortar.
 - n) Concrete Finishes : Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
 - o) Curing : Methods and length of time.
- Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Consultant for approval as may be desired.

3.00.00

INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Owner /Consultant.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Owner /Consultant reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Owner/Consultant.

3.03.00 Grades of Concrete

Structural concrete grade shall be as per clause 4.00.00 Design of Reinforced Concrete Structures of volume: II-G/1 section-II or specified elsewhere and for other part of the work, shall be as shown on the drawing as per grade classification of IS-456. In case of liquid retaining structures, IS: 3370 shall be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Owner /Consultant.

- a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.
- b) without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Owner /Consultant. In all cases the proportioning of ingredients and works control shall be in

accordance with IS:456 and shall be adopted for use after the Owner/Consultant is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes shall be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design shall keep in view the following considerations:

- a) Consistent with the various other requirements of the mix, the quantity of water shall be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates shall be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.
- e) The finished concrete shall have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Owner/Consultant. The Contractor shall strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the Contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE – I
STRENGTH REQUIREMENT OF CONCRETE

Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)	
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40

NOTE : 1 - Concrete Grade M-15 shall be used as lean concrete for simple foundations for masonry walls..Grades of concrete lower than M-20 shall not be used in reinforced concrete. These mixes need not be designed.

TABLE - II
MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE
DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT
VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/CEMENT/RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm	38 mm	20 mm	38 mm
		Size	size	size	size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0
Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6

Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE : 1 - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Owner /Consultant.

NOTE : 2 - It shall be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

NOTE : 3 - The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS-456 or as per cl.4.00.00 of Vol G1/sec II whichever is higher.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on -

- The requirement of strength.
- The requirement of durability.

3.07.01 Strength Requirement

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS: 456, shall be selected by trial and error. The values of water-cement ratios for different grade and mix designs shall have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Owner /Consultant. Frequent checks on test shall have to be carried out and the water-cement ratios shall be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to

produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, proportions for different grades of concrete is specified in Table-9 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.07.02 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 shall be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete.

The Contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super-plasticizer. However the Contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It shall be preferable to use Melamine based plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE - III
LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

(NOTE : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Owner/Consultant)

With the permission of the Owner /Consultant, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Owner /Consultant, the compacting factor test in accordance with IS:1199.

3.09.00 Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Owner /Consultant:-

Very narrow space	- 12 mm
Reinforced concrete including foundation	- 20 mm
Ordinary Plain concrete M10 and below	- 40 mm / 20 mm
Ordinary Plain Concrete M15	- 20 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the

specified proportions, strength and consistency that shall work readily into position without segregation.

Coarse aggregate shall normally be separated into the following sizes and stacked separately in properly designed stockpiles :

40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions. Coarse aggregates more than 40mm size shall not be used in concrete.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Owner /Consultant for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum.

When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Owner/Consultant. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Owner/Consultant as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 shall be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of

Cement, water or total aggregates being measured and within + 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment shall be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner /Consultant. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Owner/Consultant, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete shall be conveyed in such a way as shall prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design shall be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Owner /Consultant, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code shall be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Consultant, shall be adopted. Concrete may have to be placed against the following types of surfaces :

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Owner /Consultant and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Owner/Consultant before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Owner /Consultant and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Owner/Consultant.

Rock foundation or construction joint shall be kept moist for at least 72 hours prior to placement. Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Owner Engineer/ Consultant shall have to be adopted.

Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry shall be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar shall be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Owner /Consultant, doubtful, in addition to immersion

vibrators the Contractor may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the Contractor shall additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Owner /Consultant. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Owner /Consultant. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Owner /Consultant. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Owner /Consultant. Any deviation therefrom shall be set right by the Contractor as instructed by the Owner /Consultant.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Owner /Consultant may direct to remove the portion and reconstruct or repair the same.

The Owner /Consultant shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and

equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints shall be formed in a manner specified in the drawings/ Instruction. Vertical construction joints shall be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint. For water retaining structures and leak-proof buildings suitable approved water bars shall be installed at the construction joints.

Where the location of the joints are not specified, it shall be in accordance with the following :

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.
- c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint shall preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal shall be submitted well in advance to the Owner /Consultant for study and approval without which no construction joint shall be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor shall always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete shall be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked

thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness with same or richer grade than the concrete under consideration), shall be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, the joint shall be left to harden for at least 12 - 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Clause 3.12.

3.14.00 Repairs, Finishes and Treatment of Concrete surfaces

- 3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection shall not be accepted and, shall have to be dismantled, removed and replaced by sound concrete without any additional cost and time to Owner. The Owner /Consultant may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he shall promptly report occurrence of any defects to the Owner /Consultant. All repair works shall be carried out as per the instructions and in the presence of the Owner /Consultant or his representative at contractor's own cost and risk. Generally, repair work shall consist of any or all of the following operations :

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth and shape.
- c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.

- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with a cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortar.
- k) Polymer modified patching and adhesive repair mortar for beams & columns.

Based on the nature of defects, any proven method of repair works suggested by owner/consultant shall be followed by the contractor without any additional cost and time to the owner.

3.14.02 Finishing Unformed Surface

A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance.

No over trowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Owner /Consultant, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Owner /Consultant may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Owner /Consultant, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing.

Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Owner /Consultant. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding.

Steps, as approved by the Owner /Consultant, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Owner /Consultant is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Owner /Consultant, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The Contractor shall arrange for the manufacturer's supervision.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Owner's Consultant's

decision regarding the adequacy of curing is final.

In case any lapse on the part of the Contractor is noticed by the Owner /Consultant, he shall inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Consultant shall be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Owner and at contractor's cost.

3.16.00 Reinforcement

Mild steel round bars, high yield strength steel, etc., shall be used as reinforcement as per drawings and directions. All reinforcement shall be Corrosion Resistant Steel.

3.16.01 Bar Bending Schedules

The Contractor shall submit to the site Engineer-in-charge. Bar Bending Schedules under Information category, with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final review of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such working drawings by the site Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, , whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that shall injure the material. Re-bending can be done only if approved by the Site Engineer-incharge /Consultant. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars

shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Owner /Consultant at exceptional cases.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 18 SWG/annealed soft iron wire in two strands. Tack welding of bars shall not be done unless permitted by the Owner /Consultant. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held.

The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They shall be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Owner/ Consultant in case he feels that placement of certain bars is not possible due to congestion. In such cases he shall not start placing any bar before obtaining clearance from the Owner /Consultant.

3.16.05 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Owner /Consultant, under certain conditions. The work shall be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified and in the Drawings.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Owner/ Consultant for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out.

Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Owner /Consultant. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Owner /Consultant. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Owner /Consultant.

3.17.00 Cold Weather Concreting

When conditions are such that any operation of concreting may be expected to be done at 5°C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40°C while placing. Positive temperature control by precooling, post-cooling or any other method, if required, shall be specified.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 Form Work

3.20.01 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The Contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Owner /Consultant prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds shall be manufactured from structural or tubular steel except when specifically permitted otherwise by the Owner /Consultant.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Reckers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Owner /Consultant about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Owner /Consultant shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used.

Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits shall be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Owner/Consultant immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork shall lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Owner /Consultant. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork.

The oiling of the formwork shall be inspected just prior to placement of concrete and redone wherever necessary.

3.20.02.01 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or reproping shall not be done except with the specific approval of the Owner /Consultant. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms shall carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The Contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.03 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Owner /Consultant. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Owner /Consultant shall be obtained.

3.20.04 Removal of Forms

Before removing any formwork, the Contractor must notify the Owner /Consultant well in advance to enable him to inspect the concrete if he so desires. The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Owner regularly.

The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Owner may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Owner /Consultant in each case.

TABLE - IV

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature °C				Temperature °C			
	Above 40°C.- 20°C - Below 40°C				Above 40°C.- 20°C.- Below 40°C			
	20°C	5°C	5°C	5°C	20°C	5°C	5°C	5°C
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1		1	1	1	
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs over 125 mm thick and								

soffit of minor beams	18	14	16		12	8	9	50% of the specif- ied 28 days strength
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40°C can be reduced to those of the temperature range of 20°C to 40°C subject to approval of the Owner.

Construction joints in beams, if required to be provided, shall be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Owner /Consultant.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal of forms shall be revised as approved by the Owner /Consultant such that the strength of this cement at the time of removal of forms match with strength of portland cement at the time of removal of form as mentioned above . This has to be supported by regular tests.

3.20.05 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Owner /Consultant :

For

- a) Sectional dimension - ± 5 mm
- b) Plumb - 1 in 1000 of height
- c) Levels - ± 3 mm before any
deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and shall not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which shall be as accurate as possible to the entire satisfaction of the Owner /Consultant. Any error, within the above tolerance limits or any other as may be specially set up by the Owner /Consultant, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.06 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Owner.

3.20.07 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Owner :

- a) Ordinary : These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) Plywood : These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Owner /Consultant. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.
- c) Ornamental: These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Owner /Consultant.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Owner. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Owner /Consultant. Items to be embedded.

- a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structural to be left embedded for future extension, special connection etc.
- d) Lugs or plugs for door and window frames occurring in concrete work.
- e) Flashing and jointing in concrete work.
- f) Any miscellaneous embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter.

In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids by using water proofing admixtures and water stoppers as specified on the drawings/specifications or as directed by the Owner /Consultant. All materials are to be procured from reliable manufacturers and must have the approval of the Owner /Consultant. Where it is the responsibility of the Contractor to supply the material, the Owner /Consultant may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints shall be obtained from the Owner/ Consultant before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board shall be equal to that of the joint being formed. It shall, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. On already concreted

surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed.

At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality\of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material shall have to be procured from reliable manufacturers as approved by the Owner /Consultant. The method of installations shall be similar to that recommended by the manufacturers for fixing on cold storage walls. On already concreted surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.

The sealing strips shall be non-metallic like rubber or P.V.C.

Sealing strips shall not have any longitudinal joint and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs.

The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Owner /Consultant. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Owner /Consultant, joints in rubber seals may have to be vulcanised.

Non-metallic sealing strips shall be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

- i) Plain
- ii) Central bulb
- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints shall be allowed only under unavoidable circumstances and with the specific approval of the Owner /Consultant.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Owner /Consultant taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 6 mm and the minimum width 230 mm unless otherwise stated. The actual size and shape shall be as shown in drawings or as specified elsewhere in the specification or as directed by the Owner /Consultant. The material shall be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties shall be generally as follows. The actual requirements may be slightly different as decided by the Owner /Consultant :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips shall be 6 mm and the minimum width 230 mm unless otherwise stated. The actual size and

shape shall be as shown in drawings/ specified elsewhere in the specification or as directed by the Owner /Consultant. The material shall be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows. The actual requirements, which shall be directed by the Owner /Consultant, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70°C
Ultimate Elongation	:	Not less than 275%

3.23.04 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed , the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 Isolation Joints

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Owner /Consultant shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Owner /Consultant. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Owner /Consultant, 6 mm down stone chips may have to be used in the mix if the thickness of the grout is 25mm or more. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Owner /Consultant, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Owner /Consultant. Admixture, if directed to be added.

Alternatively non-shrink, free flow, cementitious grout like "SikagROUT 214/Anchor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Owner /Consultant.

3.25.00 Precast Concrete

The Specification for precast concrete shall be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Owner /Consultant, casting shall have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Owner/ Consultant, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which shall not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which shall be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Owner /Consultant. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Owner /Consultant. The Contractor shall render all help with instruments, materials and men to the Owner /Consultant for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Owner /Consultant. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure (Liquid Retaining Structure)

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints. Refer cl 3.26.04, cl 3.26.05 and 3.026.07.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Owner's /Consultant's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Owner /Consultant, test certificates for the materials and samples shall be submitted by the Contractor. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint for water bearing structures and underground structures.

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation shall be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent shall be mixed with water which shall be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent shall be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N /Sq. mm
Flexural Strength	-	25 to 30 N /Sq. mm.
Tensile strength	-	15 N Sq. mm (approx)
Bonding strength to concrete	-	3 N / Sq. mm (approx)
Bonding strength to steel	-	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm . The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

The maximum permissible dosage of admixture shall be 2% (two percent) by weight of cement.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/Cu.m a melamine based super plasticizer shall be preferable.

- a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Owner /Consultant. The Contractor shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Owner /Consultant.
- b) In Plaster : The concrete surface, to be plastered, shall be hacked to Owner's /Consultant's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Owner /Consultant. If desired by the Owner /Consultant, the Contractor shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375°F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400°F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Owner/Consultant, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely.

3.26.05 Protective Coating on Inside Surface

Unless otherwise stated, Two coats cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 NOT USED

3.26.07 Polyethylene Films : Application in Walls or base of Structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6
- ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed.

On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.
- v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.
- vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

- ix) Protecting with a layer of 75 mm plain cement concrete M10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures shall be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Owner /Consultant, by using bitumen emulsion protective coating of approved manufacturer applied with two coats of Hot bituminous painting of grade 85/25 over a coat of Bitumen Primer except where special water proofing is specified for specific structures mentioned elsewhere.

3.28.00 Waterproofing by Pressure /Chemical Grouting

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Owner /Consultant and submit to the Owner /Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples shall be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Owner /Consultant.

4.03.00 Aggregates

The Contractor shall carry out any or all the tests aggregates as may be required by the Owner /Consultant in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS:3550 shall be carried out by the Contractor at regular intervals and whenever directed by the Owner /Consultant. The final acceptance criteria in case of doubt shall be as per IS:3025 & IS:456.

4.05.00 Admixture

4.05.01 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete shall be established by the Contractor by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Owner /Consultant, the Contractor shall check-up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Owner /Consultant may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Owner /Consultant. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the

embedded items or adjacent structures, the same shall be made good to the satisfaction of the Owner /Consultant.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests (As per IS 456 Clause 17.3 and 17.4)

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test (If Required)

Load tests of structural members may be required by the Owner /Consultant, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456.

If load testing is decided by the Owner /Consultant, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Owner /Consultant. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor. Alternatively, if permitted under Statutory Regulations and at the discretion of the Owner /Consultant, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification at the contractor's own cost and risk.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same shall be made good by the Contractor to the satisfaction of the Owner / Consultant without any extra cost to Owner.

6.00.00

LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions as on the original scheduled date of tender opening and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Consultant, shall be followed :-

IS : 73	-	Indian Standard Specification for Paving Bitumen
IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 269	-	Indian Standard Specification for 33 grade Ordinary Portland Cement
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
IS : 455	-	Indian Standard Specification for Portland Slag Cement
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 457	-	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete
IS : 737	-	Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose. IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.

IS : 1200	-	Indian Standard Specification for Method of (Part-V) Measurement of Formwork
IS : 1322	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
IS : 1489	-	Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2
IS : 1566	-	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
IS : 1609	-	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
IS : 1786	-	Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers
IS : 1834	-	Indian standard specification for hot applied sealing compound for joint in concrete.
IS : 2062	-	Steel for general structural purpose.
IS : 2185	-	Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2
IS : 2210	-	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
IS : 2430	-	Indian standard specification for method of sampling of Aggregate for concrete.
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators Immersion Type
IS : 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators
IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables



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IS : 2645	-	Integral Cement water proofing compound
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolona & Admixture
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Archs
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers



IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
IS : 4995	-	Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
IS : 4998	-	Indian Standard Specification for Design of Reinforced Concrete Chimneys
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS : 5513	-	Indian Standard Specification for Vicat Apparatus
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use
IS : 6909	-	Indian Standard Specification for Super-sulphated Cement
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators

IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
IS : 7242	-	Indian Standard Specification for Concrete Spreaders
IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete
IS : 7251	-	Indian Standard Specification for Concrete Finishers
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus
IS : 7861	-	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement
IS : 8043	-	Indian standard specification for hydrophobic cement
IS : 8112	-	Indian Standard Specification for 43 grade Ordinary Portland Cement
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS : 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction
IS : 10262	-	Recommended Guideline for concrete Mix Design



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- IS : 12269 - Indian standard specification for 53 grade ordinary portland cement
- IS : 12330 - Indian standard specification for sulphate resisting portland cement
- IS : 12600 - Indian standard specification for low heat portland cement





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SECTION-VII

NOT USED



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**VOLUME: II-G/2
PART-A
SECTION-VIII
GUIDELINE
FOR
FABRICATION OF STRUCTURAL STEELWORK**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-VIII
Fabrication of Structural Steelwork



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**VOLUME: II-G/2
PART-A**

SECTION-VIII

**GUIDELINE
FOR
FABRICATION OF STRUCTURAL STEELWORK**

1.00.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over and above this specification.

The Steel structure may either be Site fabricated or by Shop fabricated

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on Contractor's design drawings approved by the Consultants.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the Contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the Contractor shall be in adequate quantity to avoid delay in erection.



- e) Furnish details of structures if shop fabricated with shop painting as per requirements of this Specification.
- f) Suitably mark, bundle and pack for transport all fabricated materials.
- g) Prepare and furnish Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.02.00 **Work by others**

No work under this specification shall be provided for by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and standards**

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision as on the original scheduled date of tender opening and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

LIST OF I.S. CODES - RELEVANT TO FABRICATION OF STRUCTURAL STEEL WORK

IS Codes	Description
IS : 800 -	Code of practice for general construction in steel.
IS : 801 -	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806 -	Code of practice for use of steel tubes in general building construction.
IS : 808 -	Dimensions for rolled steel beams, channels and angle sections.
IS : 812 -	Glossary of terms relating to welding & cutting of metals.
IS : 813 -	Scheme of symbols for welding.



IS : 814 -	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815 -	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS : 816 -	Code of practice for use of metal arc welding for general construction in mild steel.
IS : 817 -	Code of practice for training & testing metal arc welders.
IS : 818 -	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS : 819 -	Code of practice for resistance spot welding for light assemblies in mild steel.
IS : 822 -	Code of practice for inspection of welds.
IS : 919 - (Part - 1&2)	Recommendations for limits and fits for engineering.
IS : 1161 -	Steel Tubes for structural purposes.
IS : 1182 -	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 - (Part - 8)	Method of measurement of steel work and iron work
IS : 1239 - (Part - 1&2)	Mild steel tubes, tubulars and other wrought steel fittings
IS : 1363 - (Part - 1 to 3)	Hexagon head bolts, screws and nuts of product grade C.
IS : 1364 - (Part - 1 to 5)	Hexagon head bolts, screws and nuts of product grade A & B.
IS : 1365 -	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS : 1367 - (Part - 1 to 18)	Technical supply conditions for threaded steel fasteners.
IS : 1608 -	Method for tensile testing of steel products.

IS : 1730 -	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS : 1852 -	Rolling and cutting tolerances for hot-rolled steel product.
IS : 1977 -	Structural steel (Ordinary quality)
IS : 2016 -	Plain washer
IS : 2062 -	Steel for general structural purposes.
IS : 2629 -	Recommended practice for hot-dip galvanising of iron and steel.
IS : 2633 -	Method for testing uniformity of coating on zinc coated articles.
IS : 3644 -	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS : 3757 -	High Strength Structural Bolt
IS : 4000 -	High strength bolts in steel structure
IS : 4759 -	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS : 4923 -	Hollow steel sections for structural use.
IS : 5334 -	Code of practice for magnetic particle flaw detection of weld.
IS : 5369 -	General requirements for plain washers and lock washer.
IS : 6005 -	Code of practice for phosphating of iron and steel.
IS : 6649 -	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS : 6623 -	Specification for high strength structural nuts.
IS : 7215 -	Tolerances for fabrication of steel structures.
IS : 7280 -	Bare wire electrode for submerged arc welding.
IS : 8500 -	Structural steel micro alloyed (medium & high strength quality).

IS : 8629 -	Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
IS : 9595 -	Recommendation for metal arc welding of carbon manganese steels.
PAINTING	
IS : 117 -	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS : 128 -	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS : 1477 - (Part - I & II)	Code of practice for painting of ferrous metal in building.
IS : 2074 -	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339 -	Specification for aluminium paints for general purposes in dual container.
IS : 2932 -	Specification for enamel, synthetic exterior type - I.
IS : 2933 -	Specification for enamel, synthetic exterior type - II.

2.04.00 **Conformity with Designs**

The Seller shall design all connections and all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Consultant keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Consultant.

Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 **Materials to be used**

2.05.01 **General**

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Owner/Consultant. If desired by the Owner / Consultant, Test Certificates of materials shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if

permitted by the Owner / Consultant, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 **Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

- 1) IS : 801 - Cold formed light gauge steel structural member.
- 2) IS : 806 - Steel tubes in general building construction.
- 3) IS : 1161 - Steel tubes for structural purpose.
- 4) IS : 2062 - Steel for general structural purpose
- 5) IS : 8500 - Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 **Electrodes**

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable:

- 1) IS : 814 - Covered electrodes for metal arc welding structural steel
- 2) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- 3) IS : 7280 - Base wire electrode for submerged arc welding.

2.05.04 **Bolts and Nuts**

All bolts and nuts shall conform to the requirements of Indian Standard

Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen : -

1) IS:1367 - Technical supply conditions for threaded fasteners.

2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Consultant.

c) High Strength Friction Grip Bolt : HSFG Bolts shall be high tensile of 20 mm dia or higher diameter and of property class 8.8 (minimum) as per IS – 1367 (Latest) for all major connection. All bolts, nuts and washers shall be procured from the approved manufacturers. The bolted joints shall be designed for friction type connection and the HT bolts shall be tightened to develop the required pretension during their installation.

2.05.05 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

- 1) IS : 2062 - Steel for general structural purpose
- 2) IS : 8500 - Structural steel - micro alloyed (medium & high strength quality)
- 3) IS : 6623 - High Strength Structural Nuts

- 4) IS : 6649 - Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 **Paints**

Paints to be used for fabricated steel under the purview of this contract shall conform to the Indian Standard Specification- Ready mixed Paint, Air Drying, Inorganic Zinc Ethyl Silicate Priming Refer Section III/volume IIG1

2.06.00 **Storage of Material**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the Contractor's yard immediately, failing which, the Consultant shall be at liberty to get the material removed. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in Contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 **Steel**

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Owner / Consultant, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 **Electrodes**

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 **Bolts, Nuts and Washers**

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 **Paints**

Paints shall be stored under cover in air tight containers. Paints supplied in

sealed containers shall be used up as soon as possible once the container is opened.

2.07.00

Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with QA/QC plan included as Appendix H. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Owner / Consultant. As far as possible, all inspection by the Owner/Consultant shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Owner / Consultant in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

- | | |
|-------------------------------|--|
| a) Steel : | Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used. |
| b) Bolts, Nuts :
& Washers | Manufacturer's certificate, dimension checks, material testing. |
| c) Electrodes : | Manufacturer's certificate, thickness and quality of flux coating. |
| d) Welders : | Qualifying Tests |
| e) Welding sets : | Performance Tests |
| f) Welds : | Inspection, X-ray, Ultrasonic tests |
| g) Paints : | Manufacturer's certificate, physical inspection reports |
| h) Galvanizing : | Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products. |

2.08.00 **Standard dimensions, forms and weights**

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 **Shop Drawings**

The Contractor shall submit to the site incharge the Schedule of Fabrication and delivery of structural steelwork. He shall start to submit progressively for information and the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work.

The sequence of submission of shop drawings shall match with the fabrication and delivery schedule. The shop drawings shall conform with the design requirements as well as specification and shall ensure the correctness of general arrangement for centre line dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. shall be entirely the Contractor's responsibility.

The approval of the drawing however shall not relieve the Contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :-

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolt location etc.
- c) Details of all connections with supporting calculations.
- d) Comparison sheets to show that the proposed alternative sections, if any, are as strong as the original sections shown on the Design Drawings.
- e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible and shall pay the Owner for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 **Fabrication:** Fabrication may be either shop fabricated or Site fabricated.

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Cutting shall be affected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only.

Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Owner / Consultant.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which shall be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gouges not more than 4 mm deep shall be permitted. Gouges greater than 4 mm, which remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 **Planning of edges**

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Owner / Consultant.

3.01.05 **Clearances**

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 **Bolted construction**

All bolted connections shall have a minimum of 2 bolts with c/c distance limited to minimum spacing as per IS: 800.

3.02.01 **Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt

passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.02.02 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings. For base plates at any level, the minimum thickness of the washer plate shall be 0.8 times of base plate thickness.

3.03.00 **Welded Construction**

3.03.01 **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands

vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as shall avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Owner /Consultant, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Consultant.

3.03.05 **Welding technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that shall ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

Minimum size of fillet weld based on thickness of thicker element connected shall be

- (a) 6 mm for plate up to 20mm thick
- (b) 8 mm for 21 to 30 mm thick
- (c) 10 mm for 31 to 50 mm thick
- (d) 12 mm for 51mm & above

All members shall be welded to the gusset for full contact length available.

Minimum fillet weld thickness for site welds shall be 8 mm with plates of thickness more than 8 mm.

Spacer plates for double and starred angle members shall be provided at a spacing of not more than 40 r (min) for compression elements and 80 r(min) for tension elements, where r (min) is r_{xx} and r_{yy} of the single angle respectively.

All gussets shall be of minimum 8mm thick. In the drawings thickness of gusset plate corresponding to forces in members shall be

- (a) 8 mm gusset plate for forces up to 15 tonnes.
- (b) 10 mm gusset plate for forces 16 – 25 tonnes.
- (c) 12 mm gusset plate for forces 26 – 40 tonnes.
- (d) 14 mm gusset plate for forces 41 - 60 tonnes.
- (e) 16 mm gusset plate for forces 61 - 80 tonnes.
- (f) 18 mm gusset plate for forces 81 - 100 tonnes.
- (g) 20 mm gusset plate for forces 101 ton and above.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06

Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg. C. However, if welding is to be undertaken at low temperature,

adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be accepted by the Owner.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

3.07.00 **Separators**

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 **Bearing Plates**

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 **Architectural Clearances**

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 **Shop connections**

- a) All shop connections shall be welded as specified on the Drawings.
- b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes.

3.11.00 **Castings**

Steel castings shall be annealed

3.12.00 **Shop erection**

The steelwork shall be checked for accuracy of fit before despatch.

3.13.00 **Shop painting**

3.13.01 **General**

Unless otherwise specified, steelwork which shall be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given final coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Consultant.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits

shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the pre-cleaning, the metal surface shall immediately painted with zinc ethyl silicate primer conforming to IS-14946..

All steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum.

3.13.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 Contact surfaces

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 Galvanizing

3.14.01 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 Surface Preparation

Members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Owner /Consultant.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all work shall be made by the Owner /Consultant at the place of manufacture prior to delivery. The Owner /Consultant shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Owner/Consultant to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 **Testing and Acceptance Criteria**

4.02.01 **General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items

The Contractor shall get the specimens tested in a laboratory approved by the Owner /Consultant and submit to the Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 **Steel**

All steel supplied by the Seller shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

Steel shall conform to IS : 2062 (latest) for rolled structural steel members.

4.02.03 **Testing Criteria for checking Lamination in raw steel plates**

All raw steel plate of thickness more than 20 mm supplied by the Seller shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Owner /Consultant.

- a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.
- b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Consultant.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop/site, if the Consultant requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item

are found to be laminated, the component shall be rejected.

4.02.04 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Owner/Consultant may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Owner /Consultant, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Owner /Consultant shall have option to reject or instruct any remedial measures to be taken.

4.02.05 **Bolts, nuts and washers**

All bolts, nuts and washers shall be procured from reputed manufacturer accepted by the Owner and shall conform to the relevant Indian Standards. If desired by the Owner, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.02.06 **Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 **Galvanizing**

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 **Tolerance**

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00

Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Owner /Consultant considers the defects rectifiable. The Owner /Consultant may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Contractor's shop/site under the terms of this contract have been successfully carried out, the steelwork shall be accepted forthwith and the Owner /Consultant shall issue an acceptance certificate, upon receipt of which, the items shall be shop painted, packed and despatched/cleared for erection if site fabricated. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00

Delivery of materials

4.05.01

General

The Contractor shall deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as shall permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02

Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as shall further facilitate identification and erection.

4.05.03

Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage

or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

The Contractor shall submit periodic test reports of all materials procured and used such as raw steel, paints, electrodes, colour coated sheets, poly carbonate sheets, sheeting fixtures, bolts, nuts & washers etc. The test reports shall indicate conformance to specifications / IS codes etc.

The Contractor shall submit test reports for all welds carried out at shop such as UT and RT reports, shall also be submitted along with each inspection call, covering structures offered for inspection.

DFT record of paint applied measured at random covering structures offered for inspection.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award of Contract

After award of the Contract the Contractor is to submit the following:

- a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Owner /Consultant on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Results of any test as and when conducted and as required by the Owner /Consultant.
- d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION-IX
GUIDELINE
FOR
ERECTION OF STRUCTURAL STEELWORK**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-IX
Erection of Structural Steelwork



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**VOLUME: II-G/2
PART-A**

SECTION-IX

**GUIDELINE
FOR
ERECTION OF STRUCTURAL STEELWORK**

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials fabricated/arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:-

- a) The Contractor shall provide all construction materials and the Contractor shall provide all transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Owner/Consultant. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures by the contractor.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Owner/Consultant. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

- e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Owner /Consultant.
- f) Final coat of Painting of the erected steel structures by the contractor. For painting of structural steel members: shall be applied with primer paint shall be single coat of zinc ethyl silicate primer of 75micron thick and conform to IS: 2074 (Latest Revision). The surface preparation shall be done in accordance with IS: 1477 (Part I & II) (Latest Revision) – Code of Practice for Finishing of Ferrous Metals in Buildings. Two coats of synthetic enamel paint conforming to IS: 2932 (Latest Revision) of approved shade and quality and not less than 50 microns each coat shall also be applied. Total Dry film thickness of the finished paint shall not be less than 175 microns. For structures fabricated in shop, one additional coat of primer shall be given at the shop of 75 micron thick.
- g) All minor modifications of the fabricated steel structures as directed by the Owner /Consultant including but not limited to the followings:
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size bolt if required.
 - iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting shall be permitted only at the discretion of the Owner /Consultant.
 - v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.
 - vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
 - vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
 - viii) Carry out tests in accordance with this Specification if directed.

The above are to be followed for the site fabricated structures also.

2.02.00 **Work by others**

No work under this Specification shall be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions as on the original scheduled date of tender opening and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.04.00 **Conformity with designs**

The Contractor shall erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the Owner /Consultant. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Owner /Consultant.

2.05.00 **Material**

2.05.01 **General**

The Contractor shall check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The Contractor shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Owner /Consultant.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract shall be supplied by the Contractor for erection work and shall be deemed to have been included in this rates.

2.05.02 **Materials to conform to Indian Standards**

All materials required to be supplied by the Seller under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 **Storage of materials**

2.06.01 **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Owner /Consultant shall be at liberty to get the materials removed by agency.

2.06.02 **Yard**

The Contractor shall have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which shall be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments.

The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

2.06.03 **Covered Store**

All field connection materials, paints, cement etc. shall be stored on well-designed racks and platforms off the ground in a properly covered store building to be built.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Owner/Consultant to assure compliance with the provisions of the Contract and shall submit the records of the same to the Owner /Consultant. The quality control operation shall include but not be limited to the following items of work:-

- 1) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- 2) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

- 3) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The Contractor shall salvage, collect and deliver all the packing materials to the Owner.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Owner /Consultant.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Owner /Consultant.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Owner /Consultant. Anchor

bolts and other anchor steel shall be embedded in position. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Owner /Consultant, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06

Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8x dia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 Holes, cutting and fitting

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Owner /Consultant.

The Contractor shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Owner /Consultant. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge

holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in fabrication work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Owner /Consultant and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 **Grouting of stanchion bases and bearings of beams and girders on concrete (Plain or reinforced)**

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm downgraded stone chips may be added to the above noted cement-sand grout mix, if required, by the Owner /Consultant or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementitious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 **Painting after erection**

Field painting, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Owner /Consultant. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which shall be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Owner /Consultant.

3.05.00 Not used

3.06.00 **Final cleaning up**

Upon completion of erection and before final acceptance of the work by the Owner /Consultant, the Contractor shall remove all falsework, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 **Safety Measures during Erection**

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

Loading tests shall be carried out on erected structures, if required by the Owner /Consultant, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Contractor responsible, to the satisfaction of the Owner /Consultant.

The structure or structural member under consideration shall be loaded with

its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Owner /Consultant.

4.01.01 **Stiffness Test**

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 **Strength Test**

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole.

Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 **Structure of same design**

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Owner /Consultant. This load shall be maintained for 24

hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. herein before.

4.02.00 **Tolerances**

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below :

Component	Description	Variation Allowed
I. For Buildings Containing Cranes		
Main columns	a) Shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical

Component	Description	Variation Allowed
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10M length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c) For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or not greater than 10 mm whichever is the least.
	b) Lateral displacement of top chord at	1/250 of depth of truss or 20 mm whichever is

Component	Description	Variation Allowed
	centre of span from vertical plane running through centre of supports	the least.
Crane Girders & Tracks	a) Difference in levels of crane rail measured between adjacent columns	2.0 mm
	b) Deviation to crane rail gauge	± 3.0 mm
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00

Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Consultant shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract. Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award

After award of the work, the contractor will be required to submit the following information

5.01.01 Tentative Programme

The contractor shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary Works & Manpower (After Award of contract)

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the contractor which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted before starting the work. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection yard (After award of contract)

A site plan showing the layout and location of the erection yard proposed to be established by the contractor shall be furnished indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the contractor shall comply with the same without any claim whatsoever.

5.01.04

Detailed Programme

The contractor shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.01.05

Fortnightly Progress Report

The contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

6.00.00

MISCELLANEOUS GUIDELINES

ERECTION PRACTICE

(a) DO'S

- (1) Carry out erection only after structures are thoroughly inspected and cleared.
- (2) Start erection from braced bay.
- (3) Ensure proper packing below the columns to have correct levels (to be checked by survey schemes)
- (4) Ensure proper anchoring of column base by tightening of all anchor bolts.
- (5) Ensure that guying is done at 2/3rd height in 3 directions 120 degree apart.
- (6) Ensure that guy ropes are fully tight and anchored .Size of the guy rope should be adequate to take loads
- (7) Provide temporary bracing wherever needed.
- (8) Outstanding of flanges of beams /columns are to be protected against local bending at location of slinging during erection.
- (9) Ensure that cross beam/bracings are erected only after the cleats/gussets are fully welded.

- (10) Do the welding of cross beams with cleats, only after ensuring all bolts are in position and are tightened fully.

(b) DON'TS

- (1) Don't leave the structures without proper guying in all directions till they are braced.
- (2) Don't miss to anchor properly at the base of columns with anchor nuts fully tightened.
- (3) Don't use manila ropes in place of steel ropes for guying.
- (4) Don't support the cross beams with temporary jigs. Ensure all the bolts are provided and tightened.
- (5) Don't use bracings/tie members for fixing lifting tackles/diversion pulleys/cable trays to avoid damages due to erection loads.
- (6) Avoid indiscriminate cutting/notching of erected and loaded structures.
- (7) Don't use column bases for anchoring guy ropes of structures.

GENERAL INSTRUCTION FOR WELDING

The Contractor shall work out welding procedure for the structures at his own responsibility and submit for Owner's/ consultant's information, considering the following factors.

- a) Specification and thickness of steel.
- b) Specification of electrode or/and base wire.
- c) Welding process (manual arc welding, submerged arc welding).
- d) Type of structures to be welded (thickness of components meeting at a joint).
- e) Pre and post heating requirement.
- f) Preparation of fusion faces.
- g) Sequence of welding.
- h) Weather condition.
- i) Use of jigs and fixtures etc.
- j) Type of non-destructive testing to be carried out.

- k) Inspection procedure to be followed.
- l) Design requirements of the joints.

Welding of any load bearing structure shall be carried out only by the person who has passed welder's qualification as per IS: 7318 (Part-I).

Contractor shall employ competent supervisors, exclusively for welding works, to ensure that the standard of workmanship and quality of materials comply with requirements of this specification.

All metal arc welding shall be carried out as per IS:9595-1996

Submerged arc welding of mild steel and low alloy steel shall be as per IS:4353-1995

Purchaser may at his own discretion order periodic tests of the Welders and/or of welds produced by them. Such tests shall be at the expense of the Contractor.

Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

Low Hydrogen electrodes and flux for submerged welding shall be dried at 250°-300° C for one hour in drying even before use.

For suitability of wire flux combination, procedure test shall be carried out as per IS: 15977-2013 if so required.

Welding shall be done by electric arc process. Generally submerged arc, automatic & Semi-automatic welding shall be employed. Only where it is not practicable, manual arc welding may be resorted to. In case of manual arc welding, recommendations of electrode manufacturer are to be strictly followed.

After completing each run of weld, all slag should be thoroughly removed and surface cleaned before starting the next run of weld. The weld metal as deposited (including tack welds if to be incorporated) shall be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and consistent contour and uniform appearance.

Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method, which does not cause grooving and other surface defects on the weld or on the parent metal.

All butt welds shall start and end with run-on and run-off plates. All such plates shall be carefully trimmed off by gas cutting after welding is over.

Fillet welds shall not be stopped at corners but shall be returned round them.

If butt weld is to be ground flush with the surface of the member as per drawing. Adequate reinforcement shall be built up and then the same shall be chipped off and ground flush. The grinding is to be done in the direction of stress flow till the transverse marks are eliminated.

Welding shall not be done under such weather conditions, which might adversely affect the efficiency of the welding and arc-strikes on parent surfaces of structures shall be strictly avoided.

Manipulators shall be used wherever necessary and shall be designed to facilitate welding and ensure that all welds are easily accessible to the operators.

Stress relieving after welding shall be done if especially called for in the drawing or specification. Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

CONTROLS IN WELDING

The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures shall be as follows and shall be conducted by the contractor at his own cost. Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

a) Visual Examination

All welds shall be 100% visually inspected to eliminate the following defects like Presence of undercuts, Visually identifiable surface cracks in both welds and base metals, Unfilled craters, Improper weld profile and size, excessive reinforcement in weld, Surface porosity etc.

b) Dye Penetration Test (DPT)

This shall be carried out in accordance with IS: 11732 – 1995, used for steel castings, for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following like Surface cracks, Surface porosity. Severity Level 3 shall be considered for acceptance.

c) Ultrasonic testing

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by

purchaser, to detect the following like Cracks, Lack of fusion, Slag inclusions, Gas porosity.

All butt welds shall be tested for 100 % length by Ultrasonic tests and report shall be submitted.

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-96 Chapter -6: Part F.

Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and Gamma-Ray Examination)

This test shall be conducted to a minimum of 2% of length of welds of each element of each butt joint for welds made by manual or semi-automatic welding and 1 % of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by purchaser to detect the following defects like gas porosity, slag inclusions, lack of penetration, lack of fusion, cracks.

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWS D1.1-96 Part E.

Any surface irregularity like undercuts, craters, pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75 x focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

ACCEPTABLE LIMITS OF DEFECTS IN WELD

Limits of Acceptability of welding defects shall be as follows.

a) Visual inspection & Dye Penetration Test –

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 6.9 & clause 6.10 of American National Standard ANSI/AWS D1.1-96 or equivalent Indian Standards for statically as well as dynamically loaded structures respectively.

b) Ultrasonic Testing –

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 6.13.1 & clause 6.13.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

c) Radiographic testing –

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clauses 6.12.1 & 6.12.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

RECTIFICATION OF DEFECTS IN WELDS

In case of detection of defects in welds, the rectification of the same shall be done as follows.

- a) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.
- b) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.
- c) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-A
SECTION-X
GUIDELINE
FOR
ROADS AND DRAINAGE**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-X
Roads and Drainage



EPC Contract Document

NLC India Limited
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Development Consultants Pvt. Ltd.

Vol. II-G2/Part-A/Section-X
Roads and Drainage

**VOLUME: II-G/2
PART-A**

SECTION-X

**GUIDELINE
FOR
ROADS AND DRAINAGE**

1.00.00 SCOPE

This specification covers all work required for the construction of R.C.C road including box-cutting, edging, Subgrade, sub-bases preparation, RC pavement slab etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 EPC package contractor shall build up the entire plant road as per the cross section of the road specified elsewhere in the spec or as per the roads drawing.

Necessary temporary approach roads to the Lay down areas shall be laid by the contractor at their own cost

All the other roads within the plant area shall be under the scope of the contractor including formation of sub-grade, sub-base and laying of RCC.

All the roads in the entire plant area within the EPC package scope will be executed by contractor. All roads included in EPC Package as shown in Plot Plan shall be constructed by the contractor as per the basic design and layout.

Work to be provided for by the Contractor:

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the followings:

- a) Furnish all labour, supervision, services, tools and plants, transportation etc. required for the work. All materials and equipment shall be supplied by Contractor.

- b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.
- c) To carry out and submit to the Owner/Consultant results of tests whenever required by the Owner /Consultant to assess the quality of work.

2.02.00 **Work to be provided for by Others**

Noworkunderthis specification shall be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision as on the original scheduled date of tender openingand/or replacements of the following or any other relevant I.S.Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.
2. IRC:19 Standard specifications and Code of Practice for Water Bound Macadam.
3. IRC:SP-11 Hand Book of Quality Control forConstruction of Roads and Runways.
4. IS:456 IndianStandardCodeof Practice forPlainandReinforced Concrete.
5. IS:2212Code of Practice for Brickwork.
6. IS:783Code of Practice for Laying of Concrete Pipes.
7. IRC:15 Code of practice for construction of Concrete Pavement.
8. IRC:58 Guidelines for the Design of plain jointedRigidPavement.
9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Owner/Consultant shall be followed.

2.04.00 **Conformity with Designs**

The Contractor shall carryout the work as per the Contractor's drawings which are approved by the Consultant and/or the Consultant's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Owner/Consultant.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross-sections and dimensions shown on the drawings or as directed by the Owner/Consultant. Permitted tolerances for road works are described hereinafter.

2.07.00 **Concrete Road and Rigid Pavement.**

Plant Roads:

Access within the plant site shall be provided by a system of roadways.

All roads & approach roads to the buildings / structures shall be of RCC roads and inspection road for Raw Water Reservoir is BT road. Bund top roads of Raw water reservoir shall be WBM Road. Ramp of Raw water reservoir shall be of RCC.

All building and facilities shall be approached by access road from the main roads, which shall either be 7.5m carriage width only.

The sub base over the well compacted subgrade of all plant service roads within plant area will initially be made of well graded granular material like locally available laterite (63mm down-graded) / stone boulders as per IRC-63 and 100mm DLC with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement after attending all pot holes, damages, undulations etc

All main plant (RCC) roads within plant area shall have rectangular RCC side drain along both sides.

All RCC Roads and parking area shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice and MOST specification (MORT&H) for movement of heavy equipment.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design or 250mm thick whichever is higher shall be laid over 100mm PCC M10 and 100mm DLC on a laterite / stone boulder sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

All the roads shall be of width as specified in Overall plot plan & Roads and drains layout contract drawings. Shoulder width shall be 1500 mm on both sides for all type of roads. The top of the shoulders/walkway on both sides shall be 200 mm above the top of the road at ends, with kerb blocks on both road sides and the top of walkway shall be laid with paver blocks of strength 30 MPa. In the Shoulder / walkway, at every 10m interval 100mm DI pipe sloping from road edge to drain shall be laid to pass on rain water from road to drain.

All the roads inside the plant area shall be of reinforced cement concrete of minimum 250 mm thick.

All type of roads shall have a minimum turning radius as per relevant IRC codes (IRC-38).

Kerbs stones shall be provided alongside of all RCC roads. Spare duct bank shall be provided under all type roads spaced at 100m intervals or wherever required as decided by the Owner/Consultant.

Sign boards shall be provided for vehicle management and shall meet the Indian standards. All signs shall be dual worded in both English and the local Indian language. Finished top (crest) of roads shall be 250mm min above the adjoining FGL. Geometric design of road shall be in accordance with IRC: 73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

The shoulder shall be laid with slope of 1 in 30.

Top level of parking area shall be flushed with crown connecting roads with cross slope. Parking area shall be provided rigid pavements & shall be provided with anti-skid interlocking concrete paver blocks.

On either side of roads, open RCC drains shall be provided. Minimum clear width of drains shall be 600mm. The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. Only RCC box culverts shall be provided for drainage and for all the underground conduits at road crossings. All culverts carrying storm water shall be cast in place RCC box culverts. The RCC drains in Boiler area, Transformer Yard area and Switch Yard area shall be with RCC perforated cover slabs with GI gratings at a regular interval of 4m.

No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The roads must be designed for the heaviest equipment of the plant and before designing the CBR test to be carried out. Road shall be designed as per IRC & MOST standards. (MORT&H).

The Cross section for Reinforced Concrete road shall be as follows:

- i) The Sub-grade, whether in cut or fill shall be well compacted to utilize its full strength. The Sub-grade shall have no soft spots or voids and undulations and shall be well compacted to achieve a minimum 95% dry density.
- ii) Laterite / Stone Boulders sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size. This shall be laid in two layers of 115mm consolidated thickness. The voids shall be filled completely with gravel/sand.
- iii) 100mm thick dry lean concrete (DLC).
- iv) 100mm thick M10 grade PCC.
- v) Topping with RCC Pavement of 250mm thick M30 mix, with double mat reinforcement of 10tor @ 200 c/c both ways or as per the design whichever is higher.
- vi) The drainage system shall be designed for precipitation intensity of 100mm per hour.

The above specified description is minimum and indicative and the contractor has to design and provide roads as per actual functional requirements and design criteria stipulated in relevant codes.

The detailed methodology for construction of concrete /rigid pavement including construction and expansion joint shall be prepared by the contractor for approval of Owner.

BT Roads and WBM Roads

BT roads (flexible pavement) shall be designed in accordance with the provision of the relevant IRC Codes of Practices.

Road shall be designed as per IRC-37: 1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads. Sub-base shall be of granular material with laterite/Broken stone (63mm downgraded) filled with 1/3 volume of gravel/sand in the interstices. This shall be of 230mm consolidated thick laid in two layers of 115mm consolidated thick. Over this 150mm thick water bound macadam course (WBM) construction with 40mm downgraded Blue Granite Metal laid in two layers of 75mm consolidated thick.

The wearing course shall be of 40mm thick bituminous macadam binder course with 12mm downgraded BG metal with 12mm thick seal coat laid

over it. Shoulder and Kerb shall be as specified elsewhere in this specification.

2.08.00 **Road Side Drains**

2.08.01 **Formation of Drains**

Generally Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 125 mm upto 0.5m depth and 150mm thick with double reinforcement for more than 0.5m depth or as per design considerations whichever is higher. RCC box culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain shall have screed concrete with 12mm blue metalchips in M20 and smooth neat cement finish over screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The slope of the drain shall be 1:1000 longitudinally in general. However, discharge velocity shall be within non-silting & non-scouring condition.

2.09.00 **Culverts (RCC)**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Owner/Consultant after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Reinforced Cement concrete shall be followed. The top level of the Culverts shall match with the top level of road.

2.10.00 **Shoulders**

The sub grade shall be compacted well and the sub base shall be 230mm consolidated thickness of stone boulders/laterite soling as per specification over which P.C.C (M20) shall be laid to required thickness. The level of the shoulder shall be in line with the road top level or at higher level based on the location which will be decided during detailed engineering. Necessary chutes to the adjoining drain shall be provided.

2.11.00 **Kerbs**

Pre cast P.C.C (M20) continuous Kerb stone 650mm (D) x 500mm (W) X100 (T) mm thick for the pavement shall be provided on both sides of carriage way of concrete roads and every 10 kerb shall be flushed to road level. Kerbs shall be laid and set in place before completing the concrete wearing surface as well as the concrete wearing surface of shoulder. Setting shall be done in

mortar where so specified. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of shoulder if the shoulder is at higher level of the road. Where the road edge forms a curve, the kerbs shall follow such curve. Gaps may be left as shown in drawings or as may be required to provide for drainage. They shall be fixed true to line and level and secured in position by approved means.

The Kerbs shall be painted as per IRC- 35 (latest edition).

3.00.00 MANHOLES AND INSPECTION CHAMBERS

The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow. All manholes and chambers are RCC grade M30.

Cement Concrete (Plain and Reinforced)

This shall be as laid down in "Guideline for Cement Concrete (Plain and Reinforced)" Part – A Section - VI.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the Consultant. No extra payment shall be made for such tests.

4.02.00 NOT USED

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.



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**VOLUME: II-G/2
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**GUIDELINE
FOR
ARCHITECTURAL WORKS**



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Vol. II-G2/Part-B/Section-I
Properties, Storage & Handling of
Common Building Materials

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FOR
PROPERTIES, STORAGE AND HANDLING OF
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**VOLUME: II-G/2
PART-B**

SECTION-I

**GUIDELINE
FOR
PROPERTIES, STORAGE AND HANDLING OF
COMMON BUILDING MATERIALS**

1.00.00 SCOPE

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or specification.

2.00.00 MATERIALS

a) Bricks

- i) Common Burnt Clay Bricks: Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws warpage or nodules or free lime, having a frog 100mm in length 40 mm in width and 10mm to 20mm deep on one of its flat sides and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc.

Compressive strength shall be as per table-1 below. The bricks, when tested, shall have a minimum average compressive strength for various classes as given in Table-1 below. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any brick tested exceeds the upper limit for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table-1 for the purpose of calculating the average compressive strength. The minimum class requirement is class 5 of compressive strength of 50 kg/sqm.

The average value of water absorption of bricks when tested shall not be more than 20% by weight. The dimensions of the Bricks shall be 230x110x70mm.

All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The rating of efflorescence shall not be more than 'moderate'.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up to the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

TABLE-1

Class Designation	Average compressive strength			
	Not less than			
	N/mm ²	(kg/cm ²)		
12.5 (125)	12.5	(125)		
10 (100)	10	(100)		
7.5 (75)	7.5	(75)		
5 (50)	5	(50)		
3.5 (35)	3.5	(35)		

- ii) Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Lime Bricks (flag Bricks) shall conform to IS 12894. The dimensions of the Fly ash bricks shall be 230x110x70mm. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with frog on one flat side and without frog on other flat side. Fly ash shall conform to IS 3812. The average compressive strength shall conform to Class 5 as given in the Table above.

Note: Fly ash bricks will be operated only for non-load bearing walls and above ground level.

Sand: Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime: Lime shall conform to class 'C' hydrated lime of IS 712

Additives: Any suitable additive considered not detrimental to the durability of bricks may be used.

Alternatively Lime may be replaced by cement in manufacturing of Fly ash bricks. The cement shall be blended at the rate of 8 to 12%

- iii) **Mechanised Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plat by appropriate proportion of fly ash and lime/cement. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and the frog shall be of 100/80 mm in length, 40 mm width and 10 to 20 mm deep on one of its flat sides as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

b) **Stone**

For all concrete works Blue Granite Metal shall only be used.

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion and for laterite this percentage is 12%. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the **Contractor** and approved samples shall be retained by the Engineer for comparison of bulk supply. The compressive strength of common types of stones shall be as per Table below.

TABLE-2

Type of stone	Maximum Water Absorption Percentage by weight	Minimum Compressive Strength kg/sq.cm
Granite	0.5	1000
Basalt	0.5	400
Lime stone(Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite(Block)	12	35

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS: 712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaken with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement (OPC grade 43) used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The **Contractor** shall submit the manufacturer's test certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the **Contractor** is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the **Contractor**. The **Contractor** shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be

properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

Generally River sand shall be used for all the works. In case of scarcity/non-availability of River sand, M-Sand may be used at the discretion of the Engineer-in-charge at site as specified elsewhere.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. However, Cold twisted steel bars conforming to IS: 1786 shall be used in this package. Hexagonal wire netting shall conform to IS: 3150. All steel bars shall be of tested quality. All wire netting shall be galvanised.. All reinforcements shall be Corrosion Resistant Steel (CRS).

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) **Lime**

Lime shall be stored in weatherproof sheds.

d) **Cement**

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to

facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the **Contractor** and shall be removed from the site immediately.

e) **Coarse and Fine Aggregates**

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) **Reinforcement**

Reinforcement(CRS) bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

4.00.00

I. S. CODES

Following are some of the important I.S. Codes and standards relevant to this Section:

IS: 1077-1970	:	Common Burnt Clay Building Bricks –Specification
IS: 2691-1972	:	Burnt clay facing bricks-Specification
IS 12894: 2002	:	Pulverized Fuel Ash-Lime bricks - Specification
IS 712: 1984	:	Specification for building limes
IS 383:2016	:	Course and fine aggregate for concrete-specification
IS 1727: 1967	:	Methods of test for pozzolanic materials
IS-269-1989	:	Ordinary Portland cement 33 grade Specification
IS-8112-1989	:	Ordinary Portland cement 43 grade specification
IS-12269-1987	:	Ordinary Portland cement 53 grade specification
IS: 3812-2003(PART1):	:	Pulverized fuel ash specifications for use of pozzolona in cement, cement mortar and concrete
IS-3812-2003(PART 2):	:	Pulverized fuel ash specifications for use as admixture in cement mortar and concrete
IS 3495(Part1): 1992	:	Determination of compressive strength of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of water absorption of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of efflorescence of burnt clay building bricks
IS 3812: 1981	:	Specification for fly ash for use as pozzolana and admixture
IS 4082: 1996	:	Recommendations on stacking and storage of Construction materials and components at site
SP 27: 1987	:	Handbook of Method of Measurement of Buildings Works



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FOR
ANTI-TERMITE TREATMENT**



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Anti-Termite Treatment



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SECTION-II

**GUIDELINE
FOR
ANTI-TERMITE TREATMENT**

1.00.00 SCOPE

The scope of work is to prevent the subterranean termites from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites while the building is under construction. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-2013 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical shall be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration as per Manufacturer recommendation.

2.02.00 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption through skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care shall be taken in the application of chemicals to see they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.03.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (20EC) (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable (20EC) Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable (20EC) Concentrate (IS: 2682 - 1984)	: 1.0
Lindane (20 EC) (IS: 632)	: 1.0

2.03.01 **Treatment**

To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check shall be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites shall be done as per IS 6313 (Part III).

2.03.02 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start from finished 500 mm to the bottom of foundation. The bottom surface and sides of excavation (up to a height of about 300 mm) for column pits, walls trenches and basements shall be

treated with chemicals at the rate of 5 litres / M² of surface area and for balance height upto FGL shall be at the rate of 7.5 lit/sqm.. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M² of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to sock the soil below at the rate of 2.25 litres per linear metre.

2.03.03 **Treatment of Top Surface of Plinth Filling**

Holes 50 cm to 75 cm deep at 100 cm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M² of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.03.04 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 cm and a depth of 75 cm at the point where they enter the building.

2.03.05 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.03.06 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 300 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil shall be tamped back into place after this operation.

3.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 2013 : Code of Practice of Anti-Termite Measures in Buildings (pre-constructional)



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IS: 632	:	Gamma-BHC (Lindane) emulsifiable Concentrates
IS: 8944 – 1978	:	Chlorpyrifosemulsifiable concentrates
IS: 8963	:	Chlorpyrifos- Technical specifications
IS: 6439 – 1978	:	Heptachlor Emulsifiable
IS: 2682 – 1984	:	Chlordane Emulsifiable
Pre-constructional chemical treatment measures.		





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Masonry and Allied Work

**VOLUME: II-G/2
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SECTION-III

**GUIDELINE
FOR
MASONRY AND ALLIED WORK**

1.00.00 SCOPE

This specification covers furnishing, providing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Masonry

2.01.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.01.02 Mortar

Mix for mortar shall be specified..

For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

2.01.03 Brick Masonry

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. For brick work in half brick wall, bricks shall be laid in stretcher bond. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar. At the joint of brick masonry with RCC column/beam/wall, the mortar shall be with rich grade to avoid shear cracks.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. The inside face of the brick work shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow spaces are left inside the joints. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.01.04 **Reinforced Brickworks**

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.01.05 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and as specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.01.06 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.01.07 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.01.08 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.01.09 **Encasing of Structural Steel**

This shall be done by building masonry work, around flanges, webs etc. of steel members and filling the gap between steel and masonry by minimum 12 mm thick rich mortar. Encased members shall be wrapped with minimum 18G chicken wire mesh when shown on drawings or instructed by the Engineer, before plastering work.

The minimum lap in chicken wire mesh shall be 50 mm.

2.02.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.03.00 **Damp Proof Membrane**

Damp proof treatment using fiber base bitumen felt shall be 6, 8 or 10 course treatments as specified in IS: 1609. The number of courses shall be as mentioned elsewhere in the specification. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are: -

IS: 1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS : 2185 : Code Practice for hollow concrete block.

IS: 1597 : Code of Practice for Construction of stone Masonry.



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IS: 1609	:	Code of Practice for laying Damp-proof treatment Using bitumen felts.
IS: 2212	:	Code of Practice for Brickwork.
IS: 2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS: 5134	:	Bitumen Impregnated Paper & Board.
SP 27: 1987	:	Handbook of Method of Measurement of Buildings Works





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**VOLUME: II-G/2
PART-B
SECTION-IV
GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-IV
Finish to Masonry and Concrete



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**VOLUME: II-G/2
PART-B**

SECTION-IV

**GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE**

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purpose shall be filled and made good before plastering.

Note: In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

2.01.01 Preparation of Surface

The cement plaster shall be 10 mm, 12mm, 15mm, 18mm or 20mm as specified.

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 **Plastering**

2.02.01 **Mortar**

Mortar for plastering shall be as specified in the specifications.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Ceiling plaster shall be completed before commencement of wall plaster.

Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 metre intervals over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface.

The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working the float shall be avoided.

All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not to nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in the plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Thickness

Where the thickness required as per specification is 20mm the average thickness of the plaster shall not be less than 20mm whether the wall treated is of brick or stone. But, In case of brick work, the minimum thickness over any portion of the surface shall be not less than 15mm.

Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the Contractor's expense by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

2.02.03

Finish

The plaster shall be finished to a true and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Precaution

Any cracks which appear in the surface and all portions which sounds hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

- i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm drawn with any suitable method with the wall while the plaster is green.
- ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150mm wide chicken wire mesh shall be fixed with U nails 150mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane shall be carried out in one go.
- iii) Due to faulty construction, if the plaster thickness increases more than 20 mm, the Contractor shall provide chicken mesh to hold the plaster, at his own cost.

Cement Plaster with a Floating coat of Neat Cement(if applicable)

The cement plaster shall be 10, 12, 15, 18 or 20mm thick, finished with a floating coat of neat cement, as described in the specification.

Specifications for this work shall be same as described above except for the additional floating coat which shall be carried out as below.

When plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a pest of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quality of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in

no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in above shall apply.

18mm/20 mm Cement Plaster (Two Coat Work)

The specification for scaffolding and preparation of surface shall be as described above.

Mortar

The mix and type of the aggregate specified shall be used for the respective coats. Generally the mix of the finishing coat unless otherwise described in the specification.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat, unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

Application

The plaster shall be applied in two coats i.e. 12 mm under coat and then 6/8mm finishing coat and shall have an average total thickness of not less than 18/20mm.

12mm under coat

This shall be applied as specified earlier except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

6/8 mm finishing coat

The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified earlier.

Specifications for curing, Finishing and Precautions shall be as describe earlier.

10 mm Cement Plaster on Cement Concrete and Reinforced Cement Concrete Work

Scaffolding

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

Preparation of Surface

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing of not more than 5 cm. Centers, the pock being made not less than 3mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

Mortars

Mortar of the specified mix using the types of sand described in the specification shall be used.

Application

To ensure even thickness and true surface, gauges of plaster 15 x 15 cm. shall be first applied at more than 1.5m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then be applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work precedes with a true straight edge not less than 2.5m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Thickness

The average thickness of plaster shall not be less than 10 mm. The minimum thickness over any portion of the surface shall not be less than 9mm.

Curing

The specification as stated earlier

Precautions

The specification as stated earlier

2.02.04

Other Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the

drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. and rubbed smooth with a trowel.

2.03.00 **Pointing to Masonry**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 NOT USED

2.05.00 **Plaster of Paris Punning**

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 3mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

2.06.00 NOT USED

2.07.00 **White Cement Putty Punning**

Plastered surfaces, where specified shall be finished with White Cement Putty punning. The material shall be from approved manufacturers and approved by the Engineer. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 sq.m. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

	PROPERTY	
1.	Tensile Adhesion Strength (N/MM ²) @ 28 Days	> 1.0
2.	Compressive Strength (N/MM ²) @ 28 Days	> 9.0
3.	Setting Time (Minutes) - Initial Final	=> 100 =< 500
4.	Water Absorption Coefficient - Kg/M ² .H ^{1/2}	< 1.0
5.	Water Capillary Absorption (ML) @ 24 Hrs.	0.8
6.	Water Retentivity %	> 98

Surface Preparation

All loosely adhering materials on the plastered wall surface is to be removed with the help of emery stone, putty blade or wire brush and clean water. The substrate shall be cleaned, free from dust, grease and loose materials. Dry

and absorbent surface shall be moistened with sufficient quantity of clean water.

Mixing

White cement putty shall be mixed slowly with 30-35% of clean water to form a paste. Mixing is to be continued for 10-15 minutes to form a uniform paste.

Application method

First coat shall be applied on well moistened plastered wall surface from bottom to upward direction uniformly with putty blade. After drying of first coat the surface shall be rubbed gently with wet sponge or putty blade to remove loose particles. Surface shall be allowed 3 hours to dry before applying the second coat. After complete drying of second coat, loose particles shall be removed by gently rubbing the surface with wet sponge or putty blade. After mixing the putty shall be utilized within 2 hours.

2.08.00

Cement Water Proofing Compound

It shall be used for cement mortar for plastering or concrete work.

Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacturer, enlisted by the Engineer-in-Charge from time to time shall be used.

The **Contractor** shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the Specification. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.

It shall be measured by weight.

The scope shall include all labour and materials involved in all the operations described above.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I. S. CODE

Important relevant code for this Section:

- | | | | |
|----|----------|---|---|
| a) | IS: 1661 | : | Code of practice for cement and cement-lime plaster finish on walls and ceilings. |
| b) | IS: 4101 | : | Code of practice for external facings and veneers. |
| c) | IS: 1200 | : | Method of Measurements of Building and Civil (Pt-XII) Engineering Works: Part: XII- Plastering and pointing |
| d) | SP 27 | : | Handbook of Method of Measurement of Buildings Works |



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-B
SECTION-V
GUIDELINE
FOR
SINGLE AND DOUBLE SKINSANDWICH METAL CLADDING**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-V
Single and Sandwich Metal Cladding



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**VOLUME: II-G/2
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SECTION-V

**GUIDELINE
FOR
SINGLE AND SANDWICH METAL CLADDING**

1.00.00 GENERAL

1.01.00 Description

1.01.01 This section covers, providing, furnishing and installation of sandwich/double skin / Single skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes, conductors etc. and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The **Contractor** shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 Applicable Codes and Standards

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The **Contractor** may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/owner's approval.

1.02.02 ASTM - American Society for Testing Materials.

1.02.02.1 A446 - Zinc-coated (Galvanized) steel sheets of structural quality.
Coils and cut lengths.

1.02.02.2 A611 - Steel, cold rolled sheet. (IS 277)

1.03.00 Submittals

The **Contractor** shall submit to the owner the following items for review before commencing work.

1.03.01 Samples

- a) Three pieces of one full sheet of standard size as recommended by the manufacturer of each type of pre-coated and preformed metal sheet for top skin and bottom skin and for single skin.
- b) Type of insulation proposed for use and its thickness and density.

- c) Fabricated sandwich metal cladding- Sample size shall be of one full sheet of standard size as recommended by the manufacturer -three nos.
 - d) Edge sealing and flashing.
- 1.03.02 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.
- 1.03.03 Manufacturer's certification of compliance with each delivery.
- 1.03.04 **Shop Drawings**
- Showing fabrication details of sandwich/double/single skin metal cladding with or without Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.
- 1.03.05 **Test Reports**
- Two copies of Test Reports and Source of Quality Control Tests.
- 1.03.06 **Supplier Certificates**
- Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.
- 1.04.00 **Product Handling**
- 1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.
- 1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.
- 1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.
- 2.00.00 PRODUCTS**
- 2.01.00 **General**
- 2.01.01 All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

- 2.01.02 Roof insulation shall have a minimum R-value of $2.083 \text{ M}^2 \text{ }^\circ\text{K/Watt}$. Thickness of sandwich cladding shall be as required to meet the specified "R" values.
- 2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.
- 2.01.04 **Material**
- 2.01.04.1 Base Material High tensile steel
- 2.01.04.2 Metal protection Zinalume
- 2.01.04.3 Organic coating Silicon Modified Polyester (SMP) Polyvinylidene Difluoride (PVF2) and plastisol to resist aggressive climate of the jobsite
- 2.01.05 Material shall be prefabricated sandwich panel with polystyrene insulation/high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and percolated profile sheeting of thickness 0.60 mm to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick of similar pre coated panel. Wherever single sheets are used for roofing and cladding the thickness of the Zinalume sheets shall be 0.8mm minimum.
- 2.01.06 Insulating core shall be average 50mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg / M^3 for polystyrene and shall have minimum R-value $2.083 \text{ M}^2 \text{ }^\circ\text{K/Watt}$.
- 2.01.07 Panel size shall be largest available size.
- 2.01.08 **Sealants**
- Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.
- 2.01.09 Profile HDPE Filler
- 2.01.09.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.
- 2.01.09.2 Metal flashing shall be of similar material and colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Wherever specified, Metal cladding may be of double skin on the side of side runner (purlins). External sheet shall be of interlocking type.

3.01.02 Providing, erecting, fitting & fixing at all elevations double skin insulated roofing / wall cladding with zincalume and profiled steel sheets made out of 0.6 mm for external and 0.5 mm thick internal sheets (TCT) permanently colour-coated zincalume steel (150gsm Zinc Aluminium alloy coating total of both as per AS 1397:1993) having 550 MPa yield strength. Colour coating shall comprise of Polyester coating of approved colour as per Vol. II-G1-Sec. IV of specific design requirement

The external sheet shall be zincalume fixed on to the hat sections with the help of specially designed carriers to hold the external zincalume cladding. The inner sheet shall have 980mm cover width, with special male / female side-laps and anti-siphoning features to prevent leakage. Two small ribs are there in between the two profiles. The inner sheet along with sub-girths of size 50mm x 50mm x 50mm manufactured out of 1.6mm GI sheet in 'C' / 'Z' shape would be fixed to the purlin by means of self-drilling fasteners (12G - 14TPI x required length). Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer-head Zinc-coated self-drilling fasteners / screws on to the sub-girths. The clips shall be concealed and no fasteners are to penetrate the external sheeting.

3.01.03 The colour coating shall comprise of SMP / super polyester PVF2. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester PVF2 coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover with special male / female side laps and anti-siphoning features to prevent leakages.

The clips shall be concealed and no fasteners are to penetrate the external sheeting. Insulation of density 100 Kg/m³ and average thickness 50 mm. conforming to IS 8183 having a thermal conductivity value of 0.034 W/mk at 50 degree C mean temperature.

Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system and the thickness shall be 0.8mm minimum.

4.00.00 EXECUTION

4.01.00 Inspection

4.01.01 the **Contractor** shall examine the area, which will be covered, and the masonry wall where the edge of the sandwich/double/single skin cladding will be fixed and the structural alignments.

4.01.02 **Contractor** shall correct any unsatisfactory conditions prior to start of work.

4.02.00 Installation

4.02.01 Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

4.02.02 Double/single skin wall cladding with / without insulation shall be installed strictly as per manufacturer specification and details.

4.02.03 All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

4.02.04 Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 Clean-Up

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-B
SECTION-VI
GUIDELINE
FOR
CARPENTRY AND JOINERY**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-VI
Carpentry and Joinery



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Vol. II-G2/Part-B/Section-VI
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**VOLUME: II-G/2
PART-B**

SECTION-VI

**GUIDELINE
FOR
CARPENTRY AND JOINERY**

1.00.00 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the specification. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified in the "Schedule of Fixtures".

2.00.00 INSTALLATION

2.01.00 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well-seasoned C P teakwood free from decay, fungal growth, boxed heart, pitch pockets or steaks on the exposed edges, splits, large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the contractor shall have the rough timber approved by the Engineer.

b) Plywood

Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Ply wood shall be BWP grade or BWR grade as per IS 303.

Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of B W R grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number of joints in one surface.

d) **Flush Doors**

Flush door shutters shall have a solid core with commercial or decorative or non-decorative (Paintable type as per IS 2202 Part I) faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall ensure that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified elsewhere in drawing/specification. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708.

Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0mm and 3.0mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.4 mm and 1.0mm for decorative veneers, provided that the combined thickness of both is not less than 2.2mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8mm to 10mm. The rebating shall be either splayed or square type as shown in the drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

Opening for glazing

When required, glazing shall be provided and unless otherwise specified the opening for glazing shall be 250mm in height and 150mm or 200mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25mm. Opening for glazing shall be provided where specified or shown in the drawing.

Tolerance

Tolerance on the width and height shall be +3 mm and tolerance on nominal thickness shall be ± 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

e) **Panelled Glazed or Panelled and Glazed Shutters**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per drawing or as recommended and approved by Engineer in charge.

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multi-paneled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Other considerations shall be as mentioned in item (d) above.

Window and Ventilator Shutters

Window and Ventilator shutters shall conform to IS 1003 (Part 2)

f) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616

Material

i) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued tighter having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture& Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5mm.

ii) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects or cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 percent.

iii) **Adhesives:** Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

iv) **Preservatives:** Veneers used for LVL shall be given preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall than be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m³ Veneers shall be scarf joined only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600mm.

Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

g) **Laminated Veneer Lumber (LVL) Door Shutters**

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals, etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricated shall take up manufacturing of shutters only if provisions of clause mentioned above fulfilled, failing which, shutters so manufactured are liable for rejection.

Panelling Materials

Plain Particle Board: Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board: Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per stated above.

Medium Density Fiber Board: Medium density fibre board used for panels shall confirm to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board: Pre-lamination in pre-laminate medium density fiber board shall confirm to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per stated above.

Glass: Glass for glazing shall confirm to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass may also be specified by the Engineer-in-Charge.

Wire Gauze: Wire gauze shall generally confirm to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

h) **Construction and Workmanship**

Laminated Veneer Lumber (LVL) paneled, glazed and panelled and glazed shutter shall be constructed in the form of LVL framework of stiles and rails with panel inserted conforming (as per stated above) of plain or perlaminated particle board, plain or perlaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beading as specified. The stiles top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutters complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon and mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubber wood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m².

All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any warp and bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

Beading: All the panels except glass and wire gauze shall be fixed with grooves but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves.

In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable handless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Mullions and glazing bars shall be stubtenoned to the maximum depth which the size of the member wood permit or to a depth of 25 mm, whichever is less.

The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL shutters shall be manufactured in factories under controlled conditions.

i) **Panelling**

Plain and perlaminated Particle Board Panelling: The panels shall be made of one piece of plain or perlaminated particle board of thickness 12 mm or more.

Wire Gauze Panelling: Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

j) **Rebating**

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or squire type as per IS 1003 (part-1).

k) **Gluing of Joints**

The contact surfaces of tenon and mortice shall be treated before putting together as per IS 1003 (part-1). All the tenon and mortice joints shall be glued together and pinned to full thickness of the door with Bamboo pins.

l) **Tolerances**

Tolerance on the size of door shutter shall be +3 mm and in thickness +1.2 mm.

m) **Location of Fittings and Accessories**

Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of

850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per scheduled by the user. The fittings shall conform to specifications as described above.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, size and shape of louver or vision panel opening shall be as specified.

n) **Finish**

All the four edges of the shutter shall be square. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

o) **Glazing**

Glazing in the shutters of door and window shall be as per in specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

p) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the "Schedule of Fixtures". However minimum number of fixtures shall be as follows:

i) **For external single leaf door :**

- 6Nos hold fast or anchor bolts.
- 4Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer.
- Rain drip

ii) **For external double leaf door:**

- 6Nos hold fast or anchor bolts.
- 4Nos 100mm long SS hinge on both shutters.

- 10mm dia& 300mm long SS tower bolt on inside face on both shutters.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer on active shutter.
- Rain drip

iii) **For external single leaf window:**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia& 300mm long SS tower bolt on inside face.
- SS pull ring minimum 6mm thick and 50~75mm dia.
- SS window stay piece.

2.02.00 **Partitions**

These shall be conform to drawings with all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

a) **Materials**

Gypsum Board conforming to IS 2095 (Part-1)

Non asbestos multi-purpose cement board conforming to IS 14862
Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminium or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

b) **Installation**

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Jointing & Finishing**

Joints of the boards are finished with specially formulated joining compounding and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services shall be incorporated before commencement of board fixing.

d) **Fitting and Fixtures**

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening shall be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services shall be incorporated before commencement of board fixing.

e) **Tolerance**

Tolerance in dimensions shall be ± 5 mm.

2.03.00

Fibre Glass Reinforced Plastic (FRP) Door Frames

Door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up to resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./sqm. and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

- a) FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.
- b) **Tolerance:** Tolerance of size of frame to be ± 2 mm. and on size of rebate to be +1 mm.
- c) **Finish:** The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour bolts and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour and shade as approved by Engineer-in-Charge.

Fixing of Frame: As described earlier

2.04.00

Fibre Glass Reinforced Plastic (F.R.P.) Shutters

- a) F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

- b) Blocks of any seasoned hard wood of bulk density not less than 450 kg / cum At 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.
- c) **Location of Fittings and Accessories:** The lock rail of door shutters shall be so placed that its centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable location by depressing the profile has been made.

Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw shall be 8/30 mm. The hinges used shall be stainless steel or aluminium.

Sampling & Criteria for conformity: As described earlier.

- d) **Finish:** Stated earlier
- e) **Fixing of Shutter:** As described earlier.

Tolerance: As described earlier.

2.05.00 **Workmanship**

2.05.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing (preferably Bitumen Painting).. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. All grills or guard bars shall be provided to windows where called for in the drawings or specification.

2.05.02 Finish

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.05.03 Surface Treatment

When shown on drawings or called for in specification, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Door and Window Frames

Shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Furniture

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.03 Cupboard Shutters

Shall operate smoothly without jamming and locks, holding chains, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.04 **Loose Furniture**

When placed on level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

- | | | |
|----------|---|---|
| IS: 4021 | - | Timber door, window and ventilator frames |
| IS: 1003 | - | Timber paneled and glazed shutters. |
| IS: 2191 | - | Wooden flush door shutter (Cellular and hollow core type) |
| IS: 2202 | - | Wooden flush door shutters (Solid core type) |
| SP 27 | - | Handbook of Method of Measurement of Buildings Works |



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

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GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES,
CURTAIN WALL, STRUCTURAL GLAZING, ETC.**



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**GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES,
CURTAIN WALL, STRUCTURAL GLAZING, ETC.**

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete including supply of glass and glazing. The scope of work shall also include the assembly at site and supply & erection of all doors, windows, louvers, glazed partitions, etc. for which fabricated materials. Supplying and fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and specification.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 733 and 1285 for chemical composition and mechanical properties. The stainless steel screws shall be grade AISI 304. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified in "Schedule of Fixtures" and the best quality from approved list of manufacturers shall only be used. The **contractor** shall specifically state the list of manufacturer's materials he proposes to use. "Schedule of Fixtures" is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the **Contractor's** responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in the specification. Each closer shall be ensured against manufacturing defect throughout the DLP and any

defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix- A.

The **Contractor** shall submit **three** samples of each type of hardware to the Engineer for approval. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the **Contractor** towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.02.00

Fabrication

2.02.01

Steel Doors, Windows, Ventilators, Louvers, etc.

a) Door Frames

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any

drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 16 G sheets.

c) **Single Sheet Door Shutters**

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

The manufacturing shall be done as specified in "Double Plate Flush Door Shutters".

d) **Sliding Doors**

These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheet.

The shutter shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted/ welded together with 3mm gusset plate at junction to form a rigid frame. Sliding doors shall be either double plate or single plate construction as called for in drawings and made out of 18 gauge steel sheets with adequate stiffeners. The **Contractor** shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in them specification, these shall be provided with top and bottom guide rails of specified size angles or T-irons and 25mm diameter pulley or with 25mm diameter ball bearing at the bottom and guide block with steel pulleys at the top. The shutters shall be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of item. Doors shall close positively to exclude rainwater from seeping in. Sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

The guide rail shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can against the walls, giving full opening when so required.

FIXING: The guide rail shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the

top shall be suitably supported from the walls. Two channel sections shall be suitably fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

The adjoining work damaged in fixing shall be made good to match the existing work.

e) **Door Threshold**

Door threshold shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

f) **Steel Windows, Sashes, and Ventilators etc.**

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings. All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc ethyl silicate primer before fixing to windows.

2.02.02 **Aluminium Door, Windows and Frames**

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 25 micron for permanent installation thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

Where required factory made evenly baked powder coated coloured aluminium extruded sections shall be used. DFT shall not be less than 0.8 mils. Colour shall be as per instruction of the Engineer-in-Charge.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by

such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with

neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.02.03

Fire Door

Hollow metal fire rated doors shall be as per IS 3614 Part-1 & Part-2. It shall be made of pressed Galvanised steel conforming to IS 277. It shall be tested at CBRI or ARAI for maximum rating of 2 hrs with vision panel. Test certificates shall be available for vision lites/ panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied shall be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates will not be allowed. Proper label conforming the type of door and the hourly rating is mandatory.

Door Frame: Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60mm (16 gauge) minimum thick G.I. sheet (zinc coating not less than 120gm/sqm) duly filled with vermiculite based concrete mix. Suitable for mounting 120 minutes fire rated door shutters. The frame is fitted with intumescent fire seal strip of size 10 x 4 mm (minimum) all-round the frame and fixing with dash fastener of approved size and make, including applying a coat of approved brand fire resistant primer. Frames shall be metered and field assembled with self tabs. All provision shall be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers shall be provided on the skirting jamb. Frames shall be provided with black plate bracket for installation on a finished plastered masonry wall opening. Once frame installed shall be grouted with cement & sand slurry of approved proportion necessary for fire doors on the clear masonry opening.

Door Shutter: Door shutters will be 50 mm thick (unless otherwise stated in the drawing) of 120 minutes fire rating conforming to IS: 3614(Part-II) tested and certified as per laboratory approved by Engineer-in-Charge with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, shall fully flush double skin door with or without vision lite. Door shall be manufactured from 1.6 mm (16 gauge) minimum thick SWG G.I. sheet (zinc coating not less than 120gm/sqm) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make (if mentioned in the drawing) including applying a coat of approved fire resistant primer. The internal construction of the door shall be rigid reinforcement pads for receiving appropriate hardware. All doors shall be factory prepared for receiving appropriate hardware and provided with necessary reinforcement hinges, locks and door closers. The edges shall be interlocked with a bending radius of 1.4 mm. For

pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf of 200 x 300mm Vision lite wherever applicable shall be provided as per manufacturer's recommendation with a bedding and screws from inside. The glass shall be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

The door leaf and frame shall have passed minimum 250hours of salt spray test.

Paint:All doors and frames shall be finished with paint as per Volume-II-G/1-Sec-IV.

2.03.00

Structural Glazing

Aluminium semi unitised vertical Structural glazing system with single glass vision panel and spandrel panel of approved make having main frame of verticals and horizontals made out of specially designed extruded aluminium sections to withstand wind pressure of 175 kg/sq.m at a height of 40m and fabricated, fixed at all levels, elevation and heights to the Masonry / RC walls with necessary clamps, brackets and anchor fasteners. All clamps and brackets shall be Mild Steel Hot dip galvanized minimum 80 microns thick and shall conform to IS: 4759-1996. The extruded aluminium section shall be anodised in approved colour with anodic coating of minimum 25 microns. Extruded section shall be of 6063 T5 or T6 alloy conforming to ASTM B 221. Any other fastening straps, nuts, bolts, rivets, washers, Fire stops at all floor levels etc. shall be in stainless steel SS 304 grade. All tapes shall be of approved make.

The system shall be designed to withstand a wind pressure of 200 kg/Sqm and shall be fixed to the masonry/RC walls with necessary clamps, brackets and anchor fasteners, clamps and brackets shall be Hot dip galvanized minimum 80 microns thick, all complete as per manufacturer's manual and specifications. The spandrel panel shall have 50mm thick fiber glass insulation of 48 kg/cum density of approved make conforming to IS-8183 and 1.0 mm thick Twiga black tissue conforming to BS 476 Part 7. This insulation shall be enclosed in a GI tray fabricated out of 1mm thk. GI sheet and fixed to the glazing framework with stainless steel fasteners.

The gap between the GI framework and the concrete framework shall be sealed with Aluminium flashing fixed with stainless steel fasteners. All gaps shall be sealed with Silicone sealant of approved brand. Insulation shall be provided in between the Structural glazing aluminium frame work (i.e., behind the spandrel glazed panel) and the structure.

Providing 6 mm thick toughened fully tempered hard coated glass(or as per thickness mentioned elsewhere) of blue/green/blue-green or approved colour having VLT = 35 to 50 % ,External reflectance= 6 to 15% ,Internal reflection = 8 to 15%, Solar factor = 0.36 to 0.43, U Factor = 2.8 to 3.0 W/sqm K etc.

2.04.00 Aluminium Curtain Wall System

2.04.01 General

- 1) Aluminium Curtain Wall System shall be designed for the following effects:
 - a) Permanent Deformation, thermal expansion.
 - b) Wind and seismic load
 - c) Air and water infiltration or leakage.
 - d) Lateral deflection per floor height
- 2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC / Department for approval after detailed scrutiny and checking design calculations and drawings.
- 3) It will be obligatory on the part of the **Contractor** to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC / Department.

2.04.02 Specification for Materials used for Curtain Wall

1	Glazing	Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass & Glazing of this book.
2	Framing system	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	Sealant	As specified in the item or silicon sealant
4	Insulation	50 mm thick rock wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion
5	Heat Reflective Toughened Glass	As specified elsewhere in the specification. Colour of any shade approved by the Engineer-in-Charge.

2.04.03 Aluminium Alloy Extruded Sections

Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in

the works. Dimensions and weights of the sections shall be as per approved drawings.

2.04.04 **Components, General specifications, Glazing, Panelling etc. for Curtain Wall System:**

These shall be generally as per relevant Chapters in this book.

2.04.05 **Scope of Work**

Preliminary Requirements

- i) The **Contractor** shall design, test, fabricate, deliver, install all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.
- ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings,
- iii) **The curtain wall system shall also include the following activities:**
 - a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.
 - b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
 - c) All thermal insulation associated with the system. (d) All fire protection associated with the system.
 - d) All copings and closure and metal cladding to complete the system.
 - e) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.
 - f) Isolation of dissimilar metals and moving parts,
 - g) Anticorrosive treatment on all metals used in the system, (i) Polyester powder coating aluminium sections,
- iv) **The **Contractor** shall also be responsible for providing the following:**
 - a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.
 - b) Mock-ups, samples and test units.

- c) Performance testing of the curtain wall framing and glazing assembly. (d) Co-ordination with the work of other trade.
 - d) Insulation with glass wool 48 kg/cum at spandrels area.
 - e) All final exterior and interior cleaning and finishing of the curtain wall system.
 - f) Protection.
 - g) As built record drawings and photographs.
 - h) All hoisting, scaffolding, staging and temporary services.
 - i) Conceptualising and design of a suitable maintenance system for curtain glazing,
- v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the Contractor. Any defect or leakage found within the Defect Liability period (DLP) shall be sealed and made good all at the risk and cost of the Contractor.
- vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details shall be designed to accommodate thermal and building movements.

2.04.06 Design Requirements

- i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.
- ii) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

2.04.06.01 Basic requirement

The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the Contractor may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

2.04.06.02 Quality Consideration and other Activities

- i) The **Contractor** while submitting the detailed design calculations shall submit the following information on the quality of materials to be used and other aspects as detailed below:
- 1) Metal quality, finishes and thickness
 - 2) Glass quality, coating and thickness and proposed manufacturer's brand names.
 - 3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer's brand name and also the name of agency proposed for fabrication work.
 - 4) Arrangement and jointing of components.
 - 5) Field connections especially mullion to mullion and transom to mullion.
 - 6) Fixing and anchorage system of typical wall unit together with structural calculations.
 - 7) Drainage system and provision in respect of water leakage in the curtain wall system.
 - 8) Provisions for thermal movements.
 - 9) Sealant and sealing methods.
 - 10) Glazing Method
 - 11) Wind load and seismic load and any other specific load considered in the design
- ii) Design concept over lightning protection link-up system of the curtain wall for connection and incorporation into the lightning conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).
- iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

2.04.06.03 **Tolerances:** Any parts of the curtain wall, when completed, shall be within the following tolerances:

- 1) Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.

- 2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.
- 3) Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

2.04.06.04 **Samples :** The **Contractor** shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the **contract** proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

2.04.06.05 **Ancillary Requirements to be fulfilled by the Contractor**

- i) The **Contractor** / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.
- ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the **Contractor** at his own cost, without claiming any thing extra under any circumstances.

2.04.07 **Execution of work**

2.04.07.01 Performance Testing - General Requirements

- i) Mock-up units shall be constructed by the **Contractor** and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.
- ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test unit for performance testing of the curtain wall shall be constructed by the **Contractor** at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.
- iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.
- iv) The **Contractor** shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

- v) Prior to the fabrication of test units, the **Contractor** shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.
- vi) **Contractor** shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.
- vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the **Contractor**.

2.04.07.02 Test of Wind Pressure

- i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.
- ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.
- iii) The variation of dynamic pressure shall be of any approximate sine curve line.
- iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.
- v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.
- vi) The deflection on the main structural parts in this condition shall not exceed :
 - 1) $1/175$ of the span between supports or 20 mm, whichever is less for vertical elements.
 - 2) $1/250$ of the span between supports for horizontal elements.
 - 3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

2.04.07.03 Test of Lateral Deflection per floor height

- i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.
- ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)

- iii) The dynamic deflection shall be applied up to ± 13 mm.
- iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.
- v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.
- vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

2.04.07.04 **Water-tightness Test**

- i) Water shall be sprinkled to the Test Unit' under wind pressure.
- ii) Pressure shall not be applied to the test unit.
- iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.
- iv) All water leakage and drainage system at the joint and the open able sash of the curtain wall system shall be observed from the outside of the chamber.
- v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.
- vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness test.
 - 1) Install the test unit.
 - 2) Hold first water-tightness test.
 - 3) Hold test of wind pressure as described above.
 - 4) Hold second water-tightness test.
 - 5) Lateral deflection test.

2.04.07.05 **Test Report:** The Contractor shall submit five copies of test report to the Engineer-in-charge.

2.04.07.06 **Cost of Performance Test**

- i) The Contractor shall allow in the contract for the cost of the performance testing and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.

- ii) **The Contractor** shall allow for amendments and adjustments to the mock-up unit as instructed and required by the Engineer-in-Charge / Architect or the consultant.
- iii) If the mock-up test unit fails to pass the initial testing, **the Contractor** shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.
- iv) Cost of corrections to the test unit and the cost of retesting shall be borne by **the Contractor**.
- v) The **Contractor** shall be allowed six calendar months time after the work is awarded to set up the test unit and conduct the required test as described above to the satisfaction of the Engineer-in-charge.
- vi) In case the **Contractor** fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to take necessary action as per the condition of contract.

2.04.07.07 **Record of Test and Drawings**

- i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.
- ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.
- iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

2.04.07.08 **Fabrication and Erection**

- i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, which have been cut to length, mitred and mechanically jointed at the corners, Sub-dividing bar of units shall be tenoned and riveted into frames.

All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.

- ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly

same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

- iii) The sizes of different members of the curtain wall system shall be exactly as adopted for the mock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.
- iv) Care shall be taken to see that any gap between the frame and support and the frame **itself is sealed with silicon sealant.**
- v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.
- vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

2.04.08 **Representative of the Contractor**

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **For Fabricated Items**

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

- h) Provisions for hardware and fixtures to be installed at site.
- l) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.02.00

For Installed Items

- a) Installations shall be at correct location, elevation and in general on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00

INFORMATION TO BE SUBMITTED

4.01.00

After Award

- a) Names of manufacturers for doors, windows, etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

- c) Before starting fabrication of all metal doors, windows, etc. the **Contractor** shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.
- d) He shall submit a programme of work to be done for the approval of the Engineer.
- e) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the **Contractor** towards the end for final incorporation in the job.

5.00.00

I.S. CODES

Following are some of the important I.S. Codes as relevant to this section:

Steel doors, windows and ventilators	-	IS: 1038
Steel windows for industrial buildings	-	IS: 1361
Aluminium doors windows and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS: 1081
Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineer Purposes) – Specification	-	IS: 733
Wrought Aluminium and Aluminium Alloy sheet, and strip for General Engineer Purposes - Specification	-	IS: 737
Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes)–Specification	-	IS: 1285
Anodic coating on Aluminium and its Alloys – Specification	-	IS: 1868
Specification for Aluminium equal leg angles	-	IS: 3908
Specification for Aluminium unequal leg angles	-	IS: 3909

Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.	-	IS: 3965
Method of testing anodic coating on aluminium AndIts alloys	-	IS: 5523
Measurement of coating thickness by Eddy Current Method	-	IS: 6012
Floor springs (Hydraulically regulated) for heavy doors Specifications		IS: 6315
Dimensions of extruded hollow section and tolerances	-	IS: 6477
Handbook of Method of Measurement of Buildings Works	-	SP 27: 1987



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-B
SECTION-VIII
GUIDELINE
FOR
ROLLING STEEL SHUTTERS,
AND COLLAPSIBLE GATE**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-VIII
Rolling Steel Shutters, Grills and
Collapsible Gate



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
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Jharsuguda, Odisha

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Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-VIII
Rolling Steel Shutters, Grills and
Collapsible Gate

**VOLUME: II-G/2
PART-B**

SECTION-VIII

**GUIDELINE
FOR
ROLLING STEEL SHUTTERS,
AND COLLAPSIBLE GATE**

1.00.00 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of collapsible doors and Rolling Shutters with motor driven operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick of CR grade for shutters up to 4.5 M wide and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) NOT USED
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M
- f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. .
- i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metre per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.
- j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.
- k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 NOT USED

2.03.00 **Power Operated Shutters**

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 **Rolling Shutters**

Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitably fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type/Mechanical and electrically operated

Shutter: The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90mm for the shutters up to 3.5m width and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure of 100 kg/sq.m. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure.

Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

Spring: The spring shall be coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454 - Part I.

Roller and Brackets: The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161 to carry the torsional load with a maximum deflection of $1/360^{\text{th}}$ of span. For shutter up to 6 metre width and height not exceeding 5 metre, steel pipes of 50mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters up to clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5m and up to 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pre-tensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5 mtr, the cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearings with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15 mm and at least 4 number flats running throughout length of roller shall be provided.

In case of shutters of large opening the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

Guide Channel: The width of guide channel shall be 25mm the minimum depth of guide channels shall be as follows:

Clear width of shutter	Depth of guide channel
Up to 3.5 m	65mm
3.5m up to 8m	75mm
8m and above	100mm

The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide

channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

Cover: Top cover shall be mild steel sheets not less than 0.90mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

Power unit: Power unit shall be suitable for 3 phases, 50 cycles, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building. It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

Fixing: The arrangement for fixing in different situations in the opening shall be as per IS 6248.

Brackets shall be fixed on the lintel or under the lintel as specified with rawl plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and brackets shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in workmen like manner that the operation of the shutter is easy and smooth.

2.05.00

Shop Coat

Shutters shall be painted with one coat of zincethyl silicate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc ethyl silicate for adhesion of field coat.

2.06.00 **Erection**

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

2.07.00 **Collapsible Gate / Door**

2.07.01 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

2.07.02 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

2.07.03 **Fixing**

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centers alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work without any extra cost to Owner.

2.07.04 **Painting**

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given priming coat of zinc ethyl silicate before fixing them in position .Painting shall be the same as specified for Rolling Shutters.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the **Contractor** shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

4.00.00 I.S. CODE

- | | | |
|----------------|---|--|
| IS: 6248-1979 | - | Metal rolling shutters and rolling grills. |
| IS: 10521-1983 | - | Collapsible Gate |



EPC Contract Document

NLC India Limited
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Jharsuguda, Odisha

**VOLUME: II-G/2
PART-B
SECTION-IX
GUIDELINE
FOR
MISCELLANEOUS METAL**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-IX
Miscellaneous Metal



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SECTION-IX

**GUIDELINE
FOR
MISCELLANEOUS METAL**

1.00.00 SCOPE

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described elsewhere in the specification.

2.00.00 INSTALLATION

2.01.00 Fabrication/Casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel.
- c) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified, steel work shall be galvanised or non-galvanized steel work shall be painted with a

coat of zinc ethyl silicate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc ethyl silicate primer.

2.02.00 **Erection**

2.02.01 **Bracing**

The **Contractor** shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.02.02 **Temporary Bolting-Up**

As erection precedes the **Contractor** shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 **Turned Bolt**

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 **Welding**

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

2.02.05 **Cutting and Fitting**

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other **Contractors**. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 **Drifting**

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer

and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 **Grouting**

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the **Contractor** and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips or with non-shrink grout. Grouting shall be done as specified in G1/section II.

2.02.08 **Anchor Bolting**

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The **Contractor** shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.02.09 **Pipe Joints**

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.02.10 **Spot Painting**

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint or equivalent.

2.02.11 **Making Good**

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be of correct shape, size, weight etc. shown on drawings
- b) For installed items, the tolerances shall be follows:
 - i) Permissible deviation from straightness - 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks and other blemishes.

4.00.00

SCOPE

The **Contractor's** scope shall include for supply of materials, fabrication, shop paint and erection. This shall also include transporting the fabricated materials to the site, unloading storing and erection, including furnishing necessary temporary bracings guys, staging and planking. This shall also include cutting and drilling to steel, concrete or masonry and welding, bolting grouting and making good damages after erection and removing all rubbish and clearing the site upon completion of erection.

5.00.00

I.S. CODES

IS: 226	-	Structural Steel (Standard Quality)
IS: 800	-	Code of practice for use of structural steel in general building construction.
IS: 816	-	Use of metal arc welding for general construction in mild steel.
IS: 2812	-	Arc welding of Aluminium and Alloys
IS: 3150	-	Hexagonal Wire Netting
IS: 4948	-	Welded steel wire fabric for general use.
SP 27: 1987	-	Handbook of Method of Measurement of Buildings Works



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**VOLUME: II-G/2
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GUIDELINE
FOR
GLASS AND GLAZING**



Development Consultants Pvt. Ltd.

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Glass and Glazing



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Glass and Glazing

**VOLUME: II-G/2
PART-B**

SECTION-X

**GUIDELINE
FOR
GLASS AND GLAZING**

1.00.00 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall be included in this scope.

2.00.00 INSTALLATION

2.01.00 General

The **Contractor** shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions from approved manufacturer, shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

- a) Clear glass shall be float glass/troughed glass and shall be approved by the Engineer-in-Charge and shall be at least 6mm thick for windows and for doors & glazed partitions shall be minimum 8mm thick. . It shall be clear, float transparent, and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900. The thickness of float glass shall be measured with micrometers or a calliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity. Wired glass of 5.5mm thick minimum shall be provided all plant buildings as per the requirement except office rooms, control rooms and A/C rooms.
- b) Obscure glass shall have a cast surface in one side.
- c) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodized aluminium frame suitable for structural glazing system.

- d) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.
- e) The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The Contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table below :

SL. No.	Description	Standard Follow	Specification
1	Tensile strength kgf/cm ²	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kgf/cm ²	ASTM-D 412	22 Min.
4	Compression set % at 0° CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

Quality of glass

- a) All glass shall comply with ECBC 2007 requirements.
- b) 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low -E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside - 11%, Total Solar Energy Transmittance - 66% Reflectance-10% UV transmission - 49%, Solar Heat Gain Coefficient - 0.70 Shading Coefficient - 0.81 ,U - Factor Air 2.77 W/m²k , Sound Insulation - 31db outer lite.
- c) 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low -E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside - 30 %, Total Solar Energy Transmittance - 19%, Reflection - 9%, UV - 9 %, Solar Heat Gain Coefficient - 0.29 Shading Coefficient - 0.33,U -Factor Air - 1.9 W/m²k, Sound Insulation - 33db outer lite (# 2 surface) Glass with a combination of 6 mm thick toughen Opt float clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an

aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

2.02.00

Reflective Glass

Definitions

- i) **Shading Coefficient:** The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.
- ii) **Luminous Efficiency Constant (Key)** indicates a windows relative performance in rejection solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near-infrared energy has a Key close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Key of about 2.0.
- iii) **Resistance to Heat Conduction (R-value):** It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

Types of Coatings: There are two types of reflective glass, Pyrolytic (Hard) coated and vacuum (soft) coated.

- i) **Pyrolytic:** It is a coating applied during glass manufacture. The coating is fused in to the glass at 1200°C.
- ii) **Vacuum Coated Glass:** It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than Pyrolytic products.

Performance of Reflective Glass: The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio in %age
1.	Visible Light - Transmittance (%) - Reflectance (%)	15-46 12-24
2.	Total Solar Energy: - Transmittance (%) - Reflectance (%)	16-24 8-12
3.	Ultra Violet Rays: - Transmittance (%)	2-10
4.	U-Value - Summer - Winter	0.58 0.45
5.	Shading Coefficient	0.25-0.35

Testing: The reflective glass shall be tested for the followings:

- i) Physical/Field Test: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image shall coincide.
- ii) Laboratory Test: In the laboratory, the reflective glass shall be tested for the parameter specified in the table above.

2.03.00

Glazing, Setting and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the **Contractor**.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the **Contractor**.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the **Contractor**. The **Contractor** shall be responsible for damage of glass during handling, transportation, fixing etc.

After completion of glazing work, the **Contractor** shall remove all dirt stains, excess putty etc. clean the glass panes and leave

the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the **Contractor's** own cost.

3.00.00 ACCEPTANCE CRITERIA

- a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 IS CODES

Following are some of the important I.S.Codes relevant to this Section;

- | | | |
|-------------|---|---|
| IS : 3548 | - | Code of practice for glazing in building. |
| IS : 1083 | - | Code of practice for fixing and glazing metal doors, windows and ventilators. |
| IS : 14900 | - | Transparent Float glass- Specifications. |
| SP 27: 1987 | - | Handbook of Method of Measurement of Buildings Works |



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**VOLUME: II-G/2
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GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS**



Development Consultants Pvt. Ltd.

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**VOLUME: II-G/2
PART-B**

SECTION-XI

**GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS**

1.00.00 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work relevant to this package as listed below:

a) In Situ Finishes

- i) Integral finish to concrete base
- ii) Metallic Hardener like "Ironite" or equivalent finish
- iii) Mastic Asphalt finish
- iv) Chemical Resistant finish

b) Tiled Finishes

- a) Pressed ceramic Glazed tile
- b) Chemical Resistant(Acid or Alkali resistant Tiles Finish)
- c) Rubber, Vinyl etc.
- d) Stone slab (Marble/Granite/Kota)
- e) Vitrified tiles

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.02.00 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires that the **Contractor** shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the **Contractor**. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 **In-situ finishes**

2.01.01 NOT USED

2.01.02 NOT USED

2.01.03 Patent Stone NOT USED

2.01.04 **Cement Concrete Flooring with Metallic Hardener Topping**

Wherever floors are required to withstand heavy wear and tear, floor hardener(metallic) shall be used.

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

The base concrete shall be provided with the slopes required for the flooring. Floors should be so finished that no water is spread/ stopped in between. Accordingly the slopes shall be designed that all water should go to the drain. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it. While the surface of the concrete laid as per specification for 'Cement Concrete has been fully compacted and levelled but the concrete is still green thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations.

a) **Thickness**

The overall thickness of the finishing is 50mm laid in two layers. The bottom layer is 38mm thick in CC 1:2:4 with 12mm downgraded blue metal chips. The top layer is 12mm thick with metallic hardener.

b) **Material**

The hardening compound shall be of approved quality consisting of uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineering charge (Owner), actual samples shall be tested.

c) **Mix**

The top layer shall consist of 12mm thick layer of mix 1: 2 (1 cement: 2 stone aggregate 6mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1:4 (1 metallic concrete hardener: 4 cement) by weight or as per manufacturer's specification relevant to medium/heavy duty floor. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone

aggregate 6mm nominal size or as otherwise specified in the ratio of 1:2 (1 cement :2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

d) **Laying**

The concrete floor shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4mm thick glass strips or 2mm PVC strips or 2mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun.

The mixture so obtained shall be laid in 12mm thickness, on cement concrete floor while the concrete under bed is still very “green” within 2 to 4 hours of it’s laying. The topping shall be laid true to provide a uniform and even surface without trowel marks, pin holes etc. It shall be firmly pressed into the bottom concrete so as to have good bond with it. Just when the initial set starts the surface shall be finished smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.05 Not used.

2.01.06 **Acid or Alkali Resistant Tiles finish**

Manufacture and Finish

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100°C and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogeneous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour

Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 x 98.5 mm, 148.5 x 148.5mm and 198.5 x 198.5mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be ± 2 percent. Minimum 20 mm thick acid and alkali resistant vitrified tile shall be used.

Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for square ness and warp as per IS 4457.

Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark with Manufacturer's batch number and year of manufacturing.

Each tile may also be marked with the ISI certification mark.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The average thickness of the bedding shall be 10mm or as specified while the thickness for dado/skirting to be 20mm or specified.(the overall thickness of the Floor Finishing shall be 50mm).

Alkali resistant mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of acid alkali resistant cement per square

metre over an area up to one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope to avoid spread of water. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tile has been laid surplus cement slurry shall be cleaned off.

Pointing and finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout the lugs remaining exposed. The floor shall then be kept wet for 7 days. After surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an under bed or an adhesive layer.

2.02.01 Pressed Ceramic Tile Flooring (Fully Vitrified Tile Flooring)

Tiles shall conform to Table 12 of IS and the joint thickness in flooring shall not be more than 1mm.

a) Materials : Vitrified Tiles

The tiles shall be of approved make and shall generally conform to the approved standards. They shall be fully vitrified, flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as per drawings or as directed by the Engineer-in-Charge.. However the floor tile thickness shall not be less

than 10mm and the overall thickness of the floor finishing shall be 50mm.

Technical specifications of the tiles shall be generally conforming to the following standards:

Technical Specifications For Vitrified Tiles

No.	Property	Expected Standards
1	Deviation in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	< 0.50%
6	Mohs. Hardness	> 6
7	Flexural strength	> 27 N / mm ²
8	Abrasion resistance	< 204 mm ²
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness Min.	85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

b) Preparation of Surface for Flooring

Following procedure shall be followed:

- Sub grade**

Concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified.

- Mortar and bedding**

Cement mortar for bedding shall be prepared of mix 1:4, to a consistent paste and shall conform to the specification for materials; preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care

shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water.

Apply on an average 20 mm thick bedding of mortar over an area of 1 sq.m at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

c) **Laying Of Tiles for Flooring**

The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown / directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall / floor. White cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile. Do not use an iron hammer or some heavy material to press the tile. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles.

There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white / matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

d) **Fixing Tiles For Dado & Skirting / Facia**

The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

The back of tiles shall be cleaned off and covered with layer of approved adhesive like BAL-ENDURA or equivalent with proper trowelling as per manufacturers recommendations.

The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials.

The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

e) **Grouting Of Joints In Floor / Skirting / Dado**

The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like BAL-ENDURA or equivalent grouts.

After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

f) **Cleaning**

As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives shall not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

g) **Cleaning Agents for Vitrified Tiles**

Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and

cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

Cleaning Agents for Vitrified Tiles

Stains	Cleaning Agent
Robin Blue water	Household detergent / Warm water
Marker ink	Turpentine / Acetone /
Trichloroethylene	Acetone / Isopropyl alcohol
Pen ink	Isopropyl alcohol / Acetone
Methylene blue	Ammonia solution
Sauce	Turpentine / Acetone / Trichloroethylene / Conc. HCL
Cement	Hydrochloric acid / Bleaching
Tea powder	Sodium hydroxide / Potassium hydroxide
Coffee	Sodium hydroxide / Potassium hydroxide
Beer	Acetone / Petrol
hydroxide	Acetone / Isopropyl alcohol
Diesel	Hydrochloric acid
Lab indicator	Benzene or Toluene or Xylene
Cement and grouting	Ammonium sulphate solution
Pencil mark	
Plaster of Paris (POP)	
Stains	Cleaning Agent
Iodine (Tincture iodine)	Sodium hydroxide / Potassium hydroxide
Hair dye	Per chloric acid
Paan	Lemon juice or citric acid
Marker pen	Acetone

2.02.02

Pressed Ceramic Tiles In Skirting And Dado

The tiles shall be approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze or more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only up to 50% of the surface area of edges.

The glaze shall be free from welts, chips, craze specks, crawling or other imperfections detracting from the appearance when viewed from a distance of

one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

Dimensions and Tolerances

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5, & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when joined together (with 1mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be minimum 5 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs and capping beds shall be of the shape and dimensions as required and thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surface

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying

12mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles shall be soaked in water, washed clean and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and joined. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (swan) to the required size and their edges rubbed smooth. Skirting/ dado shall not project from the finished "surface of wall" by more than the thickness, undulations if any shall be adjusted in wall.

Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

2.02.03

Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an under bed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for under bed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.04

Rubber, Vinyl Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with an adhesive on concrete or masonry base. An under bed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be mentioned in the specification elsewhere or in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalise, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) **Mix: Under bed**

The under bed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty: 1 part cement: 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up. The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an under bed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.05

Stone Slab Finish: Marble, Granite Stone and Kota Stone

a) **Dressing of slabs**

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all wave ness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surface is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the stone slabs shall be true, square and free from chippings and the surface shall be true and plane.

b) **Thickness**

The under bed shall be average 20 mm thick. The thickness of the slabs shall be 18 to 20 mm or as specified. Tolerance of $\pm 3\%$ shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of $\pm 2\%$ shall be allowed. The overall thickness of the Floor Finish shall be 50mm.

c) **Stone Slab**

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

d) **Laying**

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand)

The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any place under the slab shall be not less than 12mm.

The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the stone slabs as given in the specification.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/streaks or as directed by the Engineer-in-Charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

Slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as desired by the engineer-in-charge or drawing.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified. However; the joints shall be so fine in the case of stone slabs that grouting shall not be called for. Cement slurry with or without pigment shall not be applied on the surface before each polishing. In case of granite only Shop Polished slabs shall be laid.

2.02.06

Marble Stone In Risers Of Steps And Skirting

Marble Stone Slabs and Dressing of slabs shall be as specified in Clause no. 2.02.05 except that the thickness of the slabs shall be 18mm. A tolerance of $\pm 3\%$ shall be allowed, unless otherwise specified

Preparation of Surface

It shall be as explained earlier. The wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting shall project by more than thickness of stone.

Laying

The riser of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed in to the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1cement: 3 coarse sand) or other mix as specified. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Curing, Polishing and Finishing

It shall be as specified and as far as possible, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

2.02.07 NOT USED

2.02.08 NOT USED

2.02.09 **Kota Stone In Risers of Steps, Skirting and Dado**

Kota Stone Slabs and Dressing shall be as specified in 2.02.05 except that the thickness of the slabs shall be 20mm or as specified. The slabs may be of uniform size if required.

Preparation of surface shall be as specified in 2.02.06.

Laying shall be as specified in 2.02.06 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

Curing, Polishing and Finishing shall be as specified in 2.02.06.

2.02.10

Anti-Static PVC Flooring

PVC flooring of 2mm thick shall be of approved make & brand with scratch proof, flexible & impregnated polyurethane reinforced (PUR) permanently static conductive Vinyl sheet, consists of impregnated polyurethane homogeneous mixture of PVC, plasticizers, urethane, colour pigments and filler calendared of approved colours and pattern detail. The material shall be fixed with synthetic acrylic adhesive after preparing the floor, leveling & smoothening when necessary with suitable putty, as per the design & instruction of the Engineer-in-charge. Electrical resistance shall be min $R10^8$ ohm as per ESD approval, SP-method 2472. Anti-static sheets shall be confirming clean Room Test Class A as per ASTM F 51/100.

3.00.00

ACCEPTANCE CRITERIA

The finish shall be checked specially for :

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.00.00

I.S. CODES

Important relevant codes for this section:

- | | | |
|----------|---|--|
| IS: 777 | : | Glazed earthenware tiles |
| IS: 1196 | : | Code of practice for laying bitumen mastic flooring. |
| IS: 1197 | : | Code of practice for laying of rubber floors |
| IS: 1237 | : | Cement concrete flooring tiles |
| IS: 1443 | : | Code of practice for laying and finishing of cement concrete flooring tiles. |

IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.
IS: 4457	:	Specification for ceramic unglazed vitreous acid resisting tiles
IS: 4441	:	Code of practice for use of silicate type chemical resistant mortars.
IS: 4443	:	Code of practice for use of resin type chemical resistant mortars.
IS: 4832 (part I)	:	Specification for chemical resistant mortar: silicon type.
IS: 4832 (part II)	:	Specification for chemical resistant mortar: resin type.
IS: 4832 (part III)	:	Specification for chemical resistant mortar: sulphur type.
IS: 13753	:	Specification for dust pressed ceramic tiles with water absorption of E>10%
IS: 13755	:	Specification for dust pressed ceramic tiles with water absorption of 3%, E6% (Group B11a)
SP 27: 1987	:	Handbook of Method of Measurement of Buildings Works



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha**

**VOLUME: II-G/2
PART-B
SECTION-XII
NOT USED**



Development Consultants Pvt. Ltd.

**Vol. II-G2/Part-B/Section-XII
Not Used**



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**VOLUME: II-G/2
PART-B
SECTION-XIII
GUIDELINE
FOR
PAINTING AND POLISHING ETC.**



Development Consultants Pvt. Ltd.

**Vol. II-G2/Part-B/Section-XIII
Painting, White Washing & Polishing**



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**VOLUME: II-G/2
PART-B**

SECTION-XIII

**GUIDELINE
FOR
PAINTING AND POLISHING ETC.**

1.00.00 SCOPE

This specification covers painting, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting **Contractor** shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting **Contractor** shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting **Contractor** shall obtain the approval of the Engineer in writing, regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. **Contractor** shall keep record of number of coats of painting. Before applying second coat, the **Contractor** shall obtain prior approval of Engineer in Charge

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be Grade-1 quality from well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained from the same manufacturing batch.

All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

- a) **NOT USED**
- b) **NOT USED**
- c) **NOT USED**
- d) **Exterior emulsion Painting on Wall**

Material: The paint shall be (Textured exterior paint / Acrylic smooth exterior emulsion paint / premium acrylic smooth exterior emulsion paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the **Contractor** in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The material shall be kept in the joint custody of the **Contractor** and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface: For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. shall be repaired using white cement. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection before painting is commenced.

Application:

Base coat of water proofing cement paint – All specifications in respect of base coat of water proofing cement paint shall be as described before.

Primer shall be as per the recommendation of the manufacturer suitable for the type of paint to be applied.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with portable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-Charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The procedure shall be followed for prime coat and finish coats. The surface shall be finished as uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding and protective measures shall be as describe before.

3.00.00 PAINTING

Materials

Paints, of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved paints, shall be brought to the site of work by the Contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empties shall not be removed from the site of the work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Commencing Work

Painting shall not be started until the Engineer-in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface shall not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms shall be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application

Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, to or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying shall be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This shall be facilitated by through ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be

left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need to be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint dose not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

Precautions

All furniture, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damages done shall be made good by the **Contractor**.

4.00.00

PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

Primer

The primer for wood work, iron work or plastered surface shall be as specified

Primer for plaster / wood work / Iron & Steel / Aluminium surfaces shall be as specified below.

Table-1

Sl. No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer confirming to IS 3585
3.	(A) Aluminium and light alloys	Zinc ethyl silicate primer
	(B) Iron, Steel and Galvanized steel	zinc ethyl silicate primer.
4.	Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces	As recommended by the paint manufacturer.

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

- i) **White Lead:** The white lead shall be pure and free from adulterants like barium sulphate and whiting. It shall confirm to IS 103.
- ii) **Red Lead:** This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall confirm to IS 102.
- iii) **Raw Linseed Oil:** Raw linseed oil shall be lightly viscous bit clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little small. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall confirm in all respects to IS 75. The oil shall be of approved brand and manufacture.

- iv) **Double Boiled Linseed Oil:** This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine: Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall confirm to IS 533.

All the above materials shall be approved manufacture and brought to site in their original packing in sealed condition.

4.01.00 Preparation of Surface

- 4.01.01. **Wooden Surface:** The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in

water and mixing with strong glue sized and used hot. Appropriate filler material confirming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

- 4.01.02. **Iron and Steel Surface:** All rust and scales shall be removed by scrapping or by brushing with wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

- 4.01.03. **Plastered Surface:** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

Application

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described before.

Treatment on Steel for Aggressive Environment

A second coat of ready mixed zincethyl silicate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat is to be applied after placing the member in position and just before applying Paint. Unless otherwise specified the second coat of primer is not necessary in case of painting with synthetic enamel Paint.

5.00.00 PAINTING RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint /exterior paint of the building or other type of Paint as specified

Painting New Surface

Preparation of Surface: The surface shall be prepared for priming coat as described earlier.

Application: The number of coat of painting over the priming coat shall be as stipulate in the specification. The application of Paint over priming coat shall be carried out as specified above.

Painting on Old Surface

Preparation of Surface: If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application: The specifications for application shall be as described earlier.

6.00.00

PAINTING WITH WOOD PRESERVATIVE

Oil type wood preservative of specified quality and approved make, confirming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

Painting on New Surface

Preparation of Surface: Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

Application: The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second

coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

7.00.00

COAL TARRING

Coal tar of approved manufacture confirming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

Coal Tarring on New Surface

Preparation of Surface: This shall be done as specified in 4.01.00 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

Application: The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitable done to ensure this.

Coal Tarring on Old Surface

The work shall be done in the same manner as specified above (Coal Tarring on New Surface) except that only one coat using 0.12 litre per sqm. area shall be done.

8.00.00

Not used

9.00.00

Not used

10.00.00

INTERNALWALL PAINTING WITH ACRYLIC EMULSION PAINT

The acrylic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

Acrylic emulsion Paint of approved brand and manufacture and of the required shade shall be used.

Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commended.

Application: The number of coats shall be as stipulated in the specification. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Precautions

- a) Old brushes if they are to be used with emulsion Paints, shall be completely dried of turpentine or oil Paints by washing in warm soap water.

Brushes shall be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

- b) In the preparation of wall for acrylic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

Painting on Old Surface

Preparation of Surface: This shall be done, generally as specified in 4.01.01 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.

Application: The number of coats to be applied shall be as specified. The number of coats shall be as stipulated in the specification. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is

applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Except the above the thinning with water shall not normally be required.

11.00.00

PAINTING WITH SYNTHETIC ENAMEL PAINT

Synthetic Enamel Paint (confirming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an under coat of shade to match the top coat as recommended by the same manufacture as far the top coat shall be used.

Painting on New Surface

Preparation of Surface: Preparation of surface shall be as specified in 4.01.00 as the case may be.

Application: The number of coats including the undercoat shall be as specified.

- a) **Under Coat:** One coat of the specified synthetic enamel Paint of shade suited to the shade of the top coat, shall be applied over the primer coat and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.
- b) **Top Coat:** Top coat of synthetic enamel Paint of desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

Other details shall be as specified in 'EXTERIOR PAINTING ON WALL' as far as they applicable.

Painting on Old Surface

Preparation of Surface: Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old Paint is blistered and flaked it will be necessary to completely remove. Such removal shall be paid for separately and the painting shall be treated as on new surface.

Painting: The number of coats as stipulated shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

12.00.00 Not used.

13.00.00 PAINTING WITH ACID PROOF PAINT

Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

Preparation of surface and application shall be as specified under 11.00.00 for new/old surface as the case may be.

Other details shall be as specified in 3.00.00 as far as they applicable

14.00.00 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

Ready mixed Paint (confirming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

Preparation of surface and application shall be as specified in earlier clauses for Painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

Other details shall be specified in 3.00.00 as far as applicable.

15.00.00 FLOOR PAINTING

Floor Paint of approved brand and manufacture and of the required colour shall be used.

Preparation of Surface

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor shall then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacture and rubbed smooth.

Application

The number of coats as specified shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring shall not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

16.00.00

NOT USED

17.00.00

FRENCH SPIRIT POLISHING

Pure shellac confirming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish confirming to IS 348 can also be used.

Polishing New Surface

Preparation of Surface: The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application: The number of coats of polish to be applied shall be as specified elsewhere in the specification.

A pad of wooden cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to given an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly dampened with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Polishing Old Surface

Preparation of Surface: If the old polished surface is not much solid it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to be done like new work and will be paid for as such.

Application: The specifications shall be same as described above and as far as applicable.

Other details shall be as specified in 3.00.00 as far as they are applicable.

18.00.00 EPOXY COATING/PAINTING

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturer's specification:

One coat of primer of following proportion is to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete shall be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 - 15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

18.01.00 Protection

Furniture and other movable objects, equipment's, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

18.02.00

Cleaning up

In addition to provisions in general conditions the **Contractor** shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

19.00.00

ACCEPTANCE CRITERIA

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All French polished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes and splatters of paints shall be removed from surrounding surfaces.

20.00.00

I. S. CODE

Important relevant IS Codes for this Sections are listed below :

IS: 348	:	Specification for French polish
IS: 427	:	Specification for Distemper, dry colour as required.
IS: 428	:	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS: 2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS: 2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS: 2932	:	Specification for enamel, synthetic, exterior, type-I.
IS: 5410	:	Specification for cement paint, colour as required.
SP 27: 1987	:	Handbook of Method of Measurement of Buildings Works



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha**

**VOLUME: II-G/2
PART-B**

SECTION-XIV

**GUIDELINE
FOR
SUSPENDED CEILING**



Development Consultants Pvt. Ltd.

**Vol. II-G2/Part-B/Section-XIV
Suspended Ceiling**



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

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**VOLUME: II-G/2
PART-B**

SECTION-XIV

**GUIDELINE
FOR
SUSPENDED CEILING**

1.00.00 SCOPE

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, plaster of paris boards. Perspex etc. together with the suspension system as shown on drawing or as specified with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the scope. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of zinc ethyl silicate primer. All wood supports shall be painted with two coats of "Solignum" or other approved wood preservative before erection.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2

centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively locked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties call for in the specification. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types :

- a) Plaster of Paris boards
- b) Expanded polystyrene insulation boards
- c) Fibre insulation boards
- d) Wood particle boards
- e) Glass fibre reinforced polystyrene sheets
- f) Glass Reinforced Gypsum Board / Gypsum Board or Tiles
- g) Mineral Fibre Board
- h) Aluminium Panel – Linear / square / plank type false ceiling
- i) Calcium silicate Board or tiles

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvers etc. shall be from approved manufacturers and in thickness as specified.

The type of false ceiling shall be as specified in the relevant clauses

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and specification, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.03.00 **False ceiling systems with different materials**

2.03.01 **Glass Reinforced Gypsum (GRG) or Gypsum Moisture Resistant Tiles / Board**

- 1). Load bearing galvanized light gauge sections shall be used for supporting of (seamless) finished ceiling. G.I. channels of size 0.55 mm thickness having one flange of 300 mm. and a web of 27 mm. shall be fixed along with perimeter of ceiling, screw fixed to brick wall/partition with the help of nylon sleeves & screws at 610 mm centres. Then suspending G.I. intermediate channels of size 45 mm. 0.9 mm. thick with two flanges of size 15 mm. each from the soffit at 1200 mm centres with ceiling angle of width 25 mm X 25 mm X 0.55 mm thick fixed to soffit with G.I. cleat and steel expansion fastener. Ceiling section of 0.55 mm thickness having knurled web of 51.5 mm and two flanges of 26 mm each with lips of 10.5 mm are then fixed to the intermediate channel with the help of connecting clips and in direction perpendicular to the intermediate channel at 457 mm centres. 12 mm thick GRG/Gyp MR Board is then screw fixed to ceiling sections with 25 mm dry wall screws at 230 mm centres. The board shall be joined and finished to have a flush look.
- 2). For profiled and curved surface, supporting structure from galvanized steel shall be made in required shape. Board shall be formed in to the curved shape while wet before fixing.

2.03.02 **Mineral Fibre Board**

For laying Mineral Fibre Board in tile of 600 mm X 600 mm the supporting grid system shall be formed by light gauged galvanized steel T- sections. Supporting grid system shall be rolled formed double web galvanized tees and shall meet the requirements of ASTM C-635. Nominal size of T-section shall be 24x38 mm for main runner. Exposed flange surface i.e. 24 mm wide shall be precoated or provided with a matching coloured cap. Main supporting section shall be suspended from RCC soffit / steel member with 4 mm dia galvanized rod & spring steel clip @ 1200 mm c/c. Suspensions from RCC shall be taken using expansion fasteners. The main supporting member shall be placed @ 1200 cross T-sections is inserted into the slots provided in main supporting member at 600 mm c/c so as to give a maximum size of 1200 mm x 600 mm.

Mineral Fibre Board Tiles shall be laid onto the grid 4 nos. of PVC holding clips shall be provided for each panel.

Aluminium Panels – Linear / Square tiles (lay-in or lay-on type) / planks

Aluminium panel ceiling, perforated or un-perforated as per requirement, of approved make, colour consisting of panel 150 mm wide x 15.5 mm deep x 0.5 mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 3105 (Al.mg) for higher strength and good roll forming characteristics. The Panels about each other with a narrow V groove. Panel shall be clipped to a baked enamelled Aluminium Panel carrier of 32 mm wide x 39 mm deep x 0.95 mm thick in standard length of 5 mtr made of double baked enamelled Aluminium alloy AA 3105 (Al.mg) black with cut-outs to hold the panels in a module of 150 mm closed at a distance 1.00 mtr. Panel carrier shall be suspended by means of G.I. suspension rod 4-mm diameter and a Galvanised suspension spring clip at a distance of 1.7 mtr c/c. Paint Finish: Aluminium Panels shall be chromatised for maximum bond between metal and paint enamelled twice under high temperature, one side with a full primer and finish coat the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.

Or tile of 600mm wide and 600mm long manufactured out of 0.7mm thick Aluminium alloy AA 3105 (Al.mg). Tile ends will be raised with pips and stops to ensure positive engagement into the spring to enable for de-mounting of individual panels. The Tile sides will be sufficiently high to ensure a minimum deflection across the length of Tile. All Tiles will be bevel edged. The Tile shall be Polyester based, powder coated in white colour. The Tile shall be clipped into clip in profile of 0.5mm thick G.I. The clip in profile shall be supported from slab by means of rigid suspension of 4mm G.I. Rod, Hold on Clamp with Clip. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.

Or Aluminium lineal ceiling system shall be "Luxalon 84" C or approved equal and the installation shall be strictly as per manufacturer's instruction/specification subject to approval of the Engineer. Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre.

The carriers shall be suspended from roof by 4 mm diagalvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 12mm dia 50mm long anchor bolts and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.



3.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 I. S. CODES

IS: 2441 : Code of Practice for fixing ceiling coverings.

SP 27: 1987 : Handbook of Method of Measurement of Buildings Works



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**VOLUME: II-G/2
PART-B
SECTION-XV
GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-XV
Roof Water Proofing, Insulation & Allied Works



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**VOLUME: II-G/2
PART-B**

SECTION-XV

**GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS**

1.00.00 SCOPE

This specification covers providing, furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract. Roof water proofing shall be followed as per cl 3.02.00/4.00section IV/G1. However the following section gives the methods of waterproofing for general guidance.

2.00.00 INSTALLATION

2.01.00 Before taking up the water proofing work the construction of parapet walls, including finishing shall be completed. Similarly, the ancillary items like haunches, khurras, grooves to take the fiber cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. shall be completed and no such work shall be allowed on the area to be treated during the progress of water proofing treatment or even later.

2.01.01 There is no necessity of hacking the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

2.01.02 Grading Under bed

The surface to receive the under bed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the under bed.

The under bed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The under bed shall be cured under water for at least 7 days.

The under bed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster.

For higher thickness the under bed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

- 2.01.03 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 **Concrete**

The concrete shall be used where the sub-grade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable. The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 **Insulation**

The **contractor** shall furnish the specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the **Contractor** shall send samples of insulating material to the Engineer, and after approval of the samples, the **Contractor** shall procure and transport the bulk material to the site. Whenever asked by the Engineer, The **Contractor** shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.03.01 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The **Contractor** shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work.

If the Engineer is not satisfied about the efficiency of the workers the **Contractor** shall have to secure manufacturer's supervision.

Material: Expanded polystyrene shall conform to IS 4671. It is of two types given below :

Type N-Normal

Type SE – It shall be of self extinguishing type when tested in accordance with IS 4671.

Dimensions: The size of the finished boards shall be 1.0 x 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100mm.

Tolerance: The tolerances on the length, width and thickness of the finished board shall be \pm mm.

Requirements for Expanded Polystyrene for General Use:

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
1.	Thermal conductivity (k. value) (a) at 0°C (b) at 10°C	0.34 0.37	0.32 0.35	0.30 0.33	0.29 0.32	0.28 0.30	IS 3346
2.	Compressive strength at 10% deformation in kg/sq.cm Minimum.	0.7	0.9	1.1	1.4	1.7	IS 4671
3.	Cross breaking strength in kg/sq.cm Minimum.	1.4	1.6	1.8	2.2		IS 4671
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671
6.	Water absorption	Less than 0.5% by volume (after 24 hrs. immersion)					IS 4671

Sampling: In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judgment conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table given below. The sample shall be taken at random from the lot.

No. of items in the lot	No. of sample items	Permissible number of defective sample items
1	2	3
Up to 25	3	0

26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

General: Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

2.03.02

With Resin Bonded Fiber Glass Wool (Bonded Mineral Wool)

Material: The material shall be mineral wool made from sock slag or glass processed from a molten state in to fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall be 25, 40, 50, conform to specifications of group I of IS 8183.

Dimensions: The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cm, and length of 100, 120 and 140 cm and the thickness of the bonded material wool shall be 25, 40, 50, 65 or 75 mm.

Tolerance: For width and length, the dimensional tolerance of the bonded material wool shall be -1/2 %. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

Requirements for Fiber Glass Wool

Sl. No.	Characteristics	Group I	Test Reference
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	Not less than 90% of original thickness	Annexure. A of IS 3144
3.	Shot content max	500 micron-5% 250micron-15%	IS 8183
4.	Moisture content and absorption	Not more than 2%	IS 3144
5.	In combustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg. C	0.49 mw/ cm°C	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

General: Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool

can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

2.04.00 **Fillets**

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.05.00 **Water proofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, and light traffic. The application shall be resistant to growth of fungus and proof against saltpeter action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.06.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.07.00 **Elastomeric Membrane**

2.07.01 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with

airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per liter depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.07.02 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform joint less elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface shall be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by at least 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the supervision of approved authorized agency.

2.08.00 **Under Deck Insulation**

2.08.01 Insulation material shall be Closed Cell Elastomeric Nitrile Rubber

2.08.02 Density of Material shall be between 40 to 60 Kg/m³

2.08.03 Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m²K at an average temperature of 0°C

2.08.04 The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990

2.08.05 Material shall be FM (Factory Mutual), USA approved.

2.08.06 Water vapour permeability shall not exceed 0.017 Perm inch (2.48×10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor ' μ ' value shall be minimum 7000.

2.08.07 Under-deck insulation thickness shall be as per HVAC requirement and calculation.

2.08.08 Under-deck insulation shall be provided for all AC areas having roof/floor exposed to sun/hot environment.

2.09.00 **For vertical surfaces (Parapet)**

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls (2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: **Waterproofing materials shall be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person.**

3.00.00 **ACCEPTANCE CRITERIA**

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or under bed.

4.00.00 **I.S. CODES AND STANDARDS**

- | | | | |
|----|---------|---|--|
| a) | IS:73 | : | Paving Bitumen |
| b) | IS:702 | : | Industrial Bitumen |
| c) | IS:1203 | : | Methods of testing tar and bitumen |
| d) | IS:1322 | : | Bitumen felts for waterproofing and damp proofing |
| e) | IS:1346 | : | Code of Practice for waterproofing of roofs with bitumen felts |



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- f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.
- g) IS:2645 : Specification for integral water proofing compounds for cement mortar and concrete.
- h) IS:3144 : Methods of test for mineral wool thermal insulation materials.
- i) IS:4641 : Expanded polystyrene for thermal insulation purpose.
- j) SP 27: 1987 : Handbook of Method of Measurement of Buildings Works





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**VOLUME: II-G/2
PART-B
SECTION-XVI
GUIDELINE
FOR
SHEET WORK IN ROOF AND SIDE WALL**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-XVI
Sheet Work in Roof & Side Wall



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
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**VOLUME: II-G/2
PART-B**

SECTION-XVI

**GUIDELINE
FOR
SHEET WORK IN ROOF AND SIDE WALL**

1.00.00 SCOPE

This specification covers the erection of Zincalume sheet plain /corrugated/trough covering to roof and side walls at various elevations and the fabrication and/or installation of gutters, flashings etc., as shown on drawings

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the **Contractor** in proper way to prevent all damage. If the materials are issued at site by the Owner, the **Contractor** shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Zincalume Sheeting

The wall cladding for buildings shall be of double skin sandwiched (wherever specified) prefabricated factory made Rockwool/PUF TR panels comprising of outer metal colour coated profile steel sheet of minimum depth 34.5 mm at 333 mm pitch & inner slightly ribbed or plain permanently colour coated steel sheet made out of 0.6 mm TCT high tensile zincalume steel (150 gsm. Zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for top sheet and 0.5 mm TCT zincalume steel (150 gsm zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for inner sheet. The sheets shall have colour coating with silicon modified polyester finish of thickness 20 microns over 5 microns (DFT) back coat on outer surface and 5microns over 5microns back coat for inner surface of the sheet. The permanently colour coated sheet shall meet the general requirements of IS:513, IS:277 & IS:14246. In between the metal sheet, there will be lamellar mineral wool insulation having density 100 kg/m³ and average thickness 50 mm conforming to IS:8183 having a thermal

conductivity value of 0.040 W/m²K at 50°C mean temp. Alternatively insulation shall be PUF having density of 40- 42Kg/m³ and a thermal conductivity value shall be as per IS:12436. The prefabricated Rockwool/PUF panels shall be supplied up to max. length of 12 m and finished with profile sheet overlap jointing arrangement. The panels shall be directly bolted on to the horizontal runners..

Note: For single skin wall cladding/ roofing, specification for outer sheet as mentioned above is to be followed and the thickness of the sheet shall be 0.8mm minimum. Flashings shall be of same material that of sheeting.

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer

Purlins: Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters and the spacing will be as specified in the drawing.

Slope: Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal or as specified in the drawing. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

Laying and Fixing: The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridges, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Sheet shall not generally be fixed in to gables and parapets. They shall be bent up along their side edges close to the wall and junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the Purlins or other roof members such as hip or valley rafters etc. with galvanized J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washers filled with white

lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron Purlins, and L hooks are used for fixing the sheet to R.S. joists, precast concrete Purlins. The length of the hook bolt shall be varied to suit the particular requirements. Alternatively Sheets may be fixed to Purlin with self-driven screws with neoprene washers as recommended by the Sheet manufacturer. Sheeting to sheeting fixing may also be done with self-driven screws with neoprene washers.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

The galvanized coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanized coating shall conform to IS 1367 9pt. XIII). The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of coating

Minimum Mass (g/m ²)	Average Thickness(μm)	Minimum Mass (g/m ²)	Individual Thickness(μm)
375	54	300	43

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt provided with bitumen and a G.I. limpet washers or a G.I. limpet washers filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

Finish: The roof when completed shall be true to lines, and slopes and shall be leak proof.

Ridges and Hips of Plain Zinalume Sheets

Ridges and Hips: Ridges and hips of Zinalume roof shall be covered with ridge and hip sections of plain Zinalume sheet with a minimum lap of 20 cm on either side over the sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain sheet, 0.6mm or 0.8 mm thick as given in the specification and shall be properly bent in shape.

Fixing: Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together with Zincalume sheet by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

Finish: The edges of the ridges and hips shall be straight from end to end and their surfaces shall be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

Valley and Flashing of Plain Zincalume Sheets

Valley and Flashing: Valley shall be 90 cm wide overall plain sheet or other size as specified in the specification bent to shape and fixed. They shall lap with the sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain Zincalume sheet of 40 cm overall width as specified in the specification bent to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not less than 25 cm.

Laying and Fixing: Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonry with the mortar of mix 1:3 (1cement: 3 coarse sand).

Finish: The edges of valley and flushing shall be straight from end to end. The surface shall be true and without bulges and depressions.

Gutters Made of Plain Zincalume Sheets

Gutters: Gutter shall be fabricated from plain Zincalume sheets of thickness as specified

Eaves gutters shall be of the shape and section specified in the specification. The overall width of the sheet referred to their in shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form rounded edges. The ends of the sheets at junction of pieces shall be hooked in to each other and beaten flush to avoid leakage.

Slope: Gutters shall be laid with a minimum slope of 1 in 120.

Laying and fixing: Gutters shall be supported on and fixed to GI flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers.

Where the brackets are to be fixed to the purlins, the bracket shall consist of 50 x 3 mm GI flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 nos. of 10 mm diameter bolts, nuts and washers. The bracket will be stiffened by provision of 50 x 3 mm flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 nos. 6 mm dia bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 no. 10 mm dia bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

The gutter shall be fixed to the brackets with 2 nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of sheet of the same thickness as the gutter and reverted to the gutter, the other end tailing in to the socket of the rain-water pipe. Wherever stop ends, angles etc., shall be provided.

Finish: The gutters when fixed shall be true to line and slope and shall be leak proof.

2.02.02

Polycarbonate Sheeting Work

Solid Polycarbonate sheet of minimum 4mm thick shall be of UV resistant and high temperature resistant. Sheet shall be of approved brand and quality, colour and transparency for ceiling/ roofing on plain, sloped, curved surfaces to any pitch or height including fixing purlins with polymer quoted galvanized self drilling, self tampering metal screws and fasteners and EPDM washers, rubber gasket with closing caps, adequate adhesive and sealants as per manufacturer's specification etc. complete but excluding the cost of purlins, rafters, trusses etc.(if any). Polycarbonate sheets shall be uniform

pigmentation and thickness without air pockets and shall conform to IS: 14443: 1997 and including cutting to required length and size including profile machine bending of sheets to achieve the desired profile by conforming minimum joints and laps as per drawing.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

- a) Side and end laps
- b) Absence of cracks, holes or damages in sheet
- c) Spacing of bolts
- d) Provision of double washers (G.I. and asbestos or bituminous washers)
- e) Proper installation of flashing

4.00.00 IS CODES

The following are some of the important IS Codes relevant to these sections:

IS: 3007	:	Code of practice for laying of asbestos cement sheets
IS: 2527	:	Code of practice for fixing rain water gutters and down pipes for roof drainage
IS: 1626	:	Specification for asbestos cement building pipes gutters and fittings
IS: 277	:	Specification for galvanised steel sheets (plain and corrugated)
IS: 1200 (PT.IX)	:	Method of measurements of building and civil engineering works: Part – 9 Roof covering (including cladding)
IS: 2633	:	Method of testing uniformity of coating on zinc coated articles.
IS: 3144	:	Method of test for mineral wool thermal insulation materials.
IS: 3346	:	Method of the determination of thermal conductivity of thermal insulation materials.
IS: 8183	:	Bonded mineral wool
SP 27: 1987	:	Handbook of Method of Measurement of Buildings Works



EPC Contract Document

**NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha**

**VOLUME: II-G/2
PART-B**

SECTION-XVII

**GUIDELINE
FOR
WATER SUPPLY**



Development Consultants Pvt. Ltd.

**Vol. II-G2/Part-B/Section-XVII
Water Supply**



EPC Contract Document

NLC India Limited
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**VOLUME: II-G/2
PART-B**

SECTION-XVII

**GUIDELINE
FOR
WATER SUPPLY**

1.00.00 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

General Requirements

Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the **Contractor**, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the **Contractor**. All water supply installation work shall be carried out through licensed plumber.

It is most important to ensure that wholesome water supply provided for drinking and culinary purpose is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be constructed a permissible substitute for complete absence of cross-connection.

Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only in to a cistern, and by a pipe or fitting discharging in to the air gap at a height above the top edge of the cistern equal to twice its normal bore, and in no case less than 15 cm.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such that can cause undue deterioration of the pipe.

Where the laying of any pipe through fouled soil or previous material is unavailable, the piping shall be properly protected from contact with such soil

or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non-return valves shall not be relied upon to prevent such back flow.

All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water damage to property and the risk of contamination of the water conveyed.

In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

Change in diameter and direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

Where the service pipe is of diameter less than 50mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or claps shall be insulated from the piping by suitable pads.

The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joints.

Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cistern which shall have supply from storage tank.

No service or supply pipe shall be connected directly to any hot water system or to any apparatus used for heating other than through a feed cistern thereof.

1.01.00

Materials

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order is to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00

Pipes and Pipe Fittings

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types:

- a) NOT USED
- b) MS/DI
- c) Reinforced Concrete
- d) U.P. V. C.
- e) Galvanized Iron- heavy & medium duty pipes- is 1239 & is 4736

However for water supply in buildings only GI pipes of Medium class as per IS 1239 shall be used. And all the pipes shall be laid inside the buildings in concealed type wherever possible.

1.03.00

Water Tanks

Water tanks shall be made of HDPE(White colour), shall be factory made and from reputed brand with proper test certificates. The capacity of tanks shall be as per drawing design or as per instruction of Engineer-in-Charge.

1.04.00

Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor)

2.00.00 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 **Pipe Lines (Plumbing and sanitary water lines)**

2.01.01 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 **Back Flow**

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 **Contamination**

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Piping**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leak proof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

a) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

b) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

d) **UPVC/**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

e) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

2.01.07 **Painting**

Where mentioned, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc ethyl silicate primer, M.S. pipes shall be given one coat of zinc ethyl silicate primer. Top coats shall be minimum 2 coats of best quality paint as specified.

2.02.00 **Polythene Water Storage Tanks**

Material

Polythene used for manufacture of tanks and manhole lids may be high density (HDPE,) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminated the water nor impart any test, colour, odour or toxicity to water.

Manufacture and Finish

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

Shape, Size and Capacity

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a clearance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank or up to the bottom of the inlet location whichever is less. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

Weight and Wall Thickness

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and the location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter in to the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

Sl. No.	Capacity (litres)	Minimum Wall Thickness (mm)	Minimum Weight of Empty Tank (kg)
1	2	3	4
1.	200	4.4	7.8
2.	300	4.4	9.0
3.	400	5.5	15.0
4.	500	6.0	18.0
5.	700	7.0	23.5
6.	1000	6.6	33.0
7.	1250	7.0	40.0
8.	1500	7.0	47.0
9.	1700	7.0	54.0
10.	2000	7.0	64.0
11.	2500	8.2	81.0
12.	3000	8.2	96.0
13.	4000	8.8	138.0
14.	5000	10.4	191.0
15.	6000	10.7	209.0

Sl. No.	Capacity (litres)	Minimum Wall Thickness (mm)	Minimum Weight of Empty Tank (kg)
16.	7500	10.7	250.0
17.	10000	11.5	363.0
18.	15000	11.5	550.0
19.	20000	13.2	814.0

2.03.00 Valve, Cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures as specified. Nominal size and material shall be as specified.

2.04.00 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains after laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main

shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.00.00 I.S.CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Pre-stressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes

IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polyethylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks
IS:4736-1986	:	Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)
SP 27	:	Handbook of Method of Measurement of Buildings Works



EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

**VOLUME: II-G/2
PART-B
SECTION-XVIII
GUIDELINE
FOR
DRAINAGE AND SANITATION**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-XVIII
Drainage & Sanitation



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**VOLUME: II-G/2
PART-B**

SECTION-XVIII

**GUIDELINE
FOR
DRAINAGE AND SANITATION**

1.00.00 SCOPE

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a plant sewer or to treatment work.

2.00.00 INSTALLATION

2.00.01 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 Rainwater Down comers & Soil and Drainage Pipes

Rainwater down-comers shall be standard, UPVC Pipes for Non Plant buildings and DI pipes for Plant buildings.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.01.01 **Unplasticized Polyvinyl Chloride (UPVC) Pipes**

This specification covers requirements for plain and socket end unplasticized polyvinyl chloride (UPVC) pipes with nominal outside diameters 40 mm to 160 mm for use for soil and waste discharge system inside buildings including ventilating and rain water applications. In this specification nominal outside diameter DN of pipes are 40, 50, 63, 75, 90, 110, 125, 140 and 160 mm. For the rain water pipes 160mm OD shall be used.

Surface colour of the pipes shall be dark shade of grey. For other details and specifications refer code IS: 13592-1992 (amended to 1995)

Above quality of pipes are divided into two types. Type –A (IS 13592) meant for rain water pipes & Type- B meant for soil pipes.

Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

Marking

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meters.

- a) Manufacturer's name or trade mark.
- b) Nominal outside dia of pipe.
- c) Type 'A'
- d) Batch number.

Dimensions

Diameter and Wall Thickness: Mean outside diameter, outside diameter at any point and wall thickness for type-A or type-B manufactured plain or with socket shall be as given in Table-1 of IS 13592.

UPVC rain water/ soil pipe shall of the dia, specified in the description of the item and shall be in nominal lengths of 2, 3, 4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerance on specified length shall be + 10mm and – 0 mm.

Fixing and Jointing

Pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x50x50 mm hard wood plugs, screwed with M.S. screws of required length i/e cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

Installation in Wall/ Concrete

The walls/concrete slots shall allow for a stress free installation. Pipes and fittings to be inserted in to the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation.

Fittings

Fittings used shall be of the same make as that of the PVC pipes injection mouldedor fabricated by the manufacturer and shall have a minimum wall thickness of 302 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings shall be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

2.01.02

Pipes-Galvanised Iron

The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HIRW or HFW screwed and socketed conforming to the requirements to IS 1239 Part – I for medium grade. They shall be of the diameter (nominal bore) specified in the specification, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

Galvanising shall conform to IS 4736: The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be clearly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be cleaned and well cut. The ends shall be cut clearly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

All tubes shall withstand a test pressure of 50 kg/sq.cm without showing defects of any kind.

Fittings: The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

2.02.00

Gutters

The gutters shall be made of G.I. or as specified elsewhere in the contract. All gutters shall be supplied by reputable specialized firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.01

Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

100 mm nominal dia	:	1 in 57
150 mm nominal dia	:	1 in 100
200 mm nominal dia	:	1 in 145
230 mm nominal dia	:	1 in 175
250 mm nominal dia	:	1 in 195
300 mm nominal dia	:	1 in 200

2.03.02

Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03

Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod

to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 **Support and Protection on Pipelines**

All pipes shall be laid with sockets leading uphill. For on/above ground level, Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. For underground, PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

For above ground level the pipes may be supported on suitable concrete support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust at the bends/turnings.

2.03.05 **Entry into structures**

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 **Ducts**

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 Manhole and Inspection Chambers

All manholes and inspection chambers shall be of RCC of Grade M30. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgment for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction

available from the manufacturer the methods as detailed hereunder shall be used.

a) **Concrete Pipes**

RCC NP3 pipes shall be used for underground sewer system. Minimum diameter of pipe shall be 200mm. The concrete pipes shall be of socket / spigot ends. Jointing of pipes shall be as per IS 783 – 1985. Care shall be taken at the time of jointing of pipe that cement mortar shall be smooth without any undulations / projections inside the pipes..

b) **Polyethylene Pipes**

The joints shall be thermo-welded or bolted as per manufacturer's instructions.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 300mm clearance on either side of the pipe for facility of laying and jointing. IS code for excavation shall be followed.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads, necessary permissions shall be secured by the Contractor from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly

the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The **contractor** shall furnish the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. Where PVC or similar pipes are allowed the **Contractor** shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) **Raised type**

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) **Squatting type**

It shall include glazed vitreous china pan with attached foot rests (Odisha Pan) and high level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. .

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, PVC/ Porcelain automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once in every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated. Sensor based urinals shall be provided at all important areas as decided by the engineer in charge.

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated. The washbasins shall preferably be of oval shaped fitted on Granite Top.

2.05.04 **Sink**

It shall be made of stainless steel. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, PVC waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer of minimum size 60cmx45cm. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 **Towel rail**

Towel rails shall be 20 mm dia. and 600mm length minimum, chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 **Toilet roll holder**

It shall be made of chromium plated hooks with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the **Contractor**.

3.00.00 **TESTING AND ACCEPTANCE**

3.01.00 **Inspection before installation**

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 **Testing of Pipelines**

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) **Smoke test**

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) **Water test**

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases:

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper shall commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer ordra in a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.04.00 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

- IS: 1172 - Code of basic requirements for water supply drainage and sanitation.
- IS: 1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.
- IS: 1239 - Mild Steel Tubes and Mild Steel Tubular and other (Pt. I& II) wrought steel pipe fittings.
- IS: 1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
- IS: 1537 - Vertically cast iron pressure pipe for water, gas & sewage.

- IS: 3486 - Cast Iron spigot & socket drain pipes.
- IS: 1742 - Code of Practice for building drainage.
- IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings.
- IS: 2470 - Code of Practice for designs and construction of septic tank for small and large installations.
- IS: 3076 - Low density polythelene pipes for potable water supplies.
- IS: 4984 - High density polythelene pipes for potable water supplies.
- IS: 1537 - Vertically cast iron pressure pipes for water, gas and sewage.
- IS: 1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.
- IS: 1230 - Cast Iron rain water pipes and fittings.
- IS: 3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.
- IS: 1729 - Sand cast iron spigot& socket soil, waste and ventilating pipes and accessories.
- IS: 1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).
- IS: 458 - Concrete pipes (with and without reinforcement)
- IS: 783 - Code of Practice for laying of concrete pipes.
- IS: 784 - Pre-stressed concrete pipes.
- IS: 651 - Salt glazed stoneware pipes & fittings.
- IS: 4127 - Code of practice for laying of glazed stoneware pipes.
- IS: 1726 - Cast Iron manhole covers and frames intended for use in drainage works.
- IS: 5961 - Cast Iron gratings for drainage purposes.
- IS: 5219 - 'P' & 'S' traps.
(Part 1)
- IS: 771 - Glazed earthen-ware sanitary appliance.
- IS: 772 - General requirements of enamelled cast iron sanitary appliances.

- IS: 774 - Flushing cistern for water closets & urinals (valve less siphonic type).
- IS: 775 - Cast Iron brackets & supports for wash basins and sinks.
- IS: 2548 - Plastic water closet seats & covers.
- IS: 2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.
- IS: 1703 - Water fittings- copper alloy float valves (horizontal plunger type) Specification.
- IS: 1795 - Specification for pillar taps for water supply purpose.
- IS: 2556 (Part-1, Part-2, Part-3, Part-4, Part-5, Part-6, Part-7, Part-14, and Part-15)
 - Part-1: General requirements
 - Part-2: Specific requirements of wash-down water closets.
 - Part-3: Specific squatting pans.
 - Part-4: Specific requirements of wash basins.
 - Part-5: Specific requirements of laboratory sinks.
 - Part-6: Specific requirements of Urinal & Partition plates.
 - Part-7: Specific requirements of accessories for sanitary
 - Part-14: Specific requirements of integrated squatting pans.
 - Part-15: Specific requirements of universal water closets.
- IS: 3989 - Specification for centrifugally cast 9spun) iron spigot and Socket soil, waste and ventilating pipes fittings and accessories.
- IS: 4827 - Specification for electroplated coating of nickel and chromium on copper and copper alloys.
- IS: 4985 - Unplasticised P.V.C pipes for potable water supply- Specifications.
- IS: 4127 - Code of Practice for Laying of Glazed Stone Ware Pipes.
- IS: 4885 - Specifications for Sewer Bricks.
- IS: 12592 - Pre-cast Concrete Manhole Covers and Frames – Specifications.
- SP 27: 1987 - Handbook of Method of Measurement of Buildings Works



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**VOLUME: II-G/2
PART-B
SECTION-XIX
GUIDELINE
FOR
SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-XIX
Safety Requirements for Construction Works

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**VOLUME: II-G/2
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SECTION-XIX

**GUIDELINE
FOR
SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS**

1.00.00 GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the **Contractor** and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work :

Indian Standard

5916	Construction with Hot Bituminous Materials.
4130	Demolition of Buildings.
3764	Excavation Work
5121	Piling & Other Deep Foundations.
4014 - (P-II)	Scaffolding, Steel Tubular.
3696 –	
(P-I & P-II)	Scaffolds and Ladders.
6922	Structures Subject to Underground Blasts.
4756	Tunneling Work.
5499	Underground Air-raid Shelters in Natural Soil.
4138	Working in Compressed Air.
7293	Working with Construction Machinery
8989	Erection of Concrete Framed Structures.

2.00.00 EXCAVATIONS

2.01.00 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material, shall be securely supported by timber or other type of shoring.



- 2.02.00 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.
- 2.03.00 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.
- 2.04.00 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.
- 2.05.00 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.
- 2.06.00 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.
- 2.07.00 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.
- 2.08.00 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.
- 2.09.00 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

3.00.00 DEMOLITION

- 3.01.00 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.
- 3.02.00 During night, red lights shall be placed on or about all the barricades.
- 3.03.00 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman shall be employed. In addition to watching



the site he shall also be responsible for maintaining all notices, lights and barricades.

- 3.04.00 All the necessary safety appliances as per IS :4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.
- 3.05.00 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.
- 3.06.00 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception shall be any power line required for demolition work itself.
- 3.07.00 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.
- 3.08.00 All the mains and meters of the building shall be removed or protected from damage.
- 3.09.00 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.
- 3.10.00 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.
- 3.11.00 All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed from the structure being demolished, and placed in piles for future cleaning or burning.
- 3.12.00 All the roads and open area adjacent to the work site shall either be closed or suitably protected.
- 3.13.00 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.
- 3.14.00 All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

4.00.00 VEHICLE

- 4.01.00 No person shall board any vehicle or equipment when it is in motion.
- 4.02.00 Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavation or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.
- 4.03.00 All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping.
- 4.04.00 Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night.
- 4.05.00 Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation.
- 4.06.00 Maximum speed of a heavy vehicle must not exceed 15 km. per hour.

5.00.00 SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING

- 5.01.00 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate strength shall be used as a safe means of access to places of work.
- 5.02.00 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.
- 5.03.00 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.
- 5.04.00 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.
- 5.05.00 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.
- 5.06.00 All working platform and stages from which workers are liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.
- 5.07.00 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise secured at least 1

m high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. The platform shall also be provided with toe boards of at least 150 mm high so placed as to prevent the fall of materials and tools from there.

- 5.08.00 All platforms or gangways, runways and the stairs shall be kept free from unnecessary obstructions, materials or junk.
- 5.09.00 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.
- 5.10.00 Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.
- 5.11.00 Every ladder shall be securely fixed at top and bottom. A ladder more than 5 m long shall have a prop.
- 5.12.00 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cm and these shall be recessed at least 12 mm into rails.
- 5.13.00 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such intermediate landings shall be provided with guard rails to a height of at least 1 m.
- 5.14.00 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of at least 1.2 m above the place of landing.
- 5.15.00 No portable single ladder shall be over 8 m in length.
- 5.16.00 Spacing between the side rails of the ladder shall not be less than 300 mm for ladders up to 3 m in length. For longer lengths, this shall be increased at 6 mm for each additional 0.3 m of length.
- 5.17.00 Metal ladders must not be used for electrical work or near electric circuit of equipment.
- 5.18.00 All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

- 5.19.00 Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.
- 5.20.00 All Planking and Decking on walkways and scaffolds shall be adequately supported at each end of the plank and intermediately if necessary. Planks shall not be allowed to cantilever beyond the last support but shall be overlapped if necessary on to the next plant.
- 5.21.00 Shuttering
- The above remarks shall be applicable for this also. Shuttering, particularly for slabs, shall be treated as a scaffold. Unfinished shuttering shall be marked as dangerous similarly the finished formwork shall be adequately supported, care being taken to avoid trap door effects.
- 6.00.00 MOBILE LIFTING APPLIANCES**
- 6.01.00 No mobile lifting appliances shall used on a sloping surface unless adequate precautions are taken to ensure stability.
- 6.02.00 Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.
- 6.03.00 Only one person shall give signals to the operator of mobile lifting appliances.
- 6.04.00 Maximum load to be lifted by lifting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.
- 6.05.00 No load shall be raised, lowered or suspended from a chain or rope having a knot in any of the part.
- 6.06.00 No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.
- 6.07.00 All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer at least once in every quarter.
- 6.08.00 When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.
- 6.09.00 No person shall walk under a load which is swinging by a lifting equipment.
- Guide rope must be attached to the load to prevent its swinging.
- 6.10.00 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.
- 6.11.00 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

- 6.11.01 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.
- 6.11.02 Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.
- 6.11.03 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine or give signals to the operator.
- 6.11.04 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working loading, each safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.
- 6.11.05 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.
- 6.11.06 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As regards **contractor's** machines the **Contractor** shall notify the safe working load of the machine to the Engineer whenever he brings any machinery to site of work and get it verified by the Engineer concerned.
- 6.12.00 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as shall reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

7.00.00 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

7.01.00 Rivetting

- 7.01.01 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.
- 7.01.02 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

- 7.01.03 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.
- 7.01.04 Hot rivet shall not be thrown across aisles and shaftways.
- 7.01.05 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.
- 7.01.06 All rivets, bolts, nuts, and other tools must be kept in boxes and not let loose, (For any further safety measures relevant Indian Standards and safety specifications of structural section shall be referred to).
- 7.02.00 Welding & Gas Cutting
- 7.02.01 All cylinders must be used and stored in upright position only.
- 7.02.02 Cylinders must be stored away from open flames and other source of heat.
- 7.02.03 Oxygen cylinders must not be stored near other cylinders containing gas or oil, grease or other combustible materials.
- 7.02.04 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.
- 7.02.05 Before a cylinder is moved, the cylinder valve must be closed.
- 7.02.06 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.
- 7.02.07 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.
- 7.02.08 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.
- 7.02.09 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.
- 7.02.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.
- 7.02.11 Cylinder valves and connections are not to be lubricated. All oily or greasy substances must be kept away from cylinders.
- 7.02.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a possibility of a spark falling on other workmen engaged in work closely.
- 7.02.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.



- 7.03.00 Steel Erection
- 7.03.01 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.
- 7.03.02 No person shall stand, walk or work beneath any suspended load.
- 7.03.03 Guide rope must be used for guiding lifting loads.
- 7.03.04 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.
- 7.03.05 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structural members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 shall be referred to.
- 8.00.00 SAFETY APPLIANCES**
- 8.01.00 Workers employed on mixing asphaltic materials, cement and lime mortars, shall be provided with protective footwear and protective goggles.
- 8.02.00 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.
- 8.03.00 Those engaged in welding works shall be provided with welder's protective eye-shields.
- 8.04.00 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
- 8.05.00 When workers are employed in sewers and manholes which are in use, the **Contractor** shall ensure that the manhole covers are opened and chambers are ventilated atleast for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.
- 8.06.00 The **Contractor** shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken :
- 8.06.01 No paint containing lead or lead products shall be used except in the form of paste or ready made paint.
- 8.06.02 Suitable face mask shall be supplied for use by them when paint is applied in the form of spray on a surface having lead paint dry rubbed and scraped.



- 8.06.03 Overalls shall be supplied by the **Contractor** to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- 8.07.00 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working inside. After coming out they shall have some disinfectant from the first aid box for proper washing
- 8.08.00 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engineer have to be kept available for the use of persons employed at the site of work and maintained in condition suitable for immediate use and **Contractor** shall take steps to ensure proper use of equipment by the workers.
- 8.09.00 All the persons entering the tunnel shall be provided with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and inshafts, safety belts shall also be provided.
- 8.10.00 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"
- 8.11.00 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.
- 8.12.00 A telephone system shall provided to ensure a positive and quick method of communication between all control location inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m
- 8.13.00 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means.
- 8.13.01 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.
- 8.13.02 By the use of two field (magnet type) telephone.
- 8.13.03 Any other suitable arrangement like walkie-talkie.
- 8.14.00 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.

- 8.15.00 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/ permanent workmen who are normally present at each working phase in each shift are given adequate training on first-aid methods to avoid employment of a separate attendant.
- 8.16.00 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.
- 8.17.00 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.
- 9.00.00 ELECTRICAL**
- 9.01.00 Only authorised persons shall handle or otherwise interfere with electrical equipment. Any person detecting electrical apparatus being handled by an unauthorised person or equipment in unsafe condition must report the matter to the Engineer concerned.
- 9.02.00 No person shall work on any live electric conductor or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf.
- 9.03.01 After isolating the equipment from the source of supply before the work begins, a sign 'DON'T SWITCH ON' must be hung on or near the switch to avoid its being accidentally or inadvertently switched on when persons are working.
- 9.03.02 Take out the fuses and keep in safe custody.
- 9.03.03 The switch may be locked if locking arrangement exists.
- 9.03.04 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.
- 9.03.05 After the work is finished take out Earthing and shorting link.
- 9.03.06 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.
- 9.03.07 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

- 9.04.00 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.
- 9.05.00 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall.
- 9.06.00 No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.
- 9.07.00 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.
- 9.08.00 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.
- 9.09.00 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.
- 9.10.00 As far as possible verbal instructions shall be avoided in case of pre-arranged shut-down of electrical apparatus.
- 9.11.00 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.
- 10.00.00 MISCELLANEOUS**
- 10.01.00 The **Contractor** shall provide necessary fencing and lights to protect the public from accident.
- 10.02.00 Fire extinguishers adequate in number shall be kept by the **Contractor** at the site of works where there is risk of fire hazard.
- 10.03.00 Adequate washing facilities shall be provided near the place of work.
- 10.04.00 When the work is done near any place where there is risk of drowning, all necessary equipment shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions shall be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.
- 10.05.00 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prominent place at the work spot. The

persons responsible for compliance of the code shall be named therein by the **Contractor**.

- 10.06.00 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the **Contractor** shall be open to inspection by the Engineer and Owner.
- 10.07.00 Notwithstanding the above clauses there is nothing in those to exempt the **Contractor** from the operations of any other Act or Rule in force in the Republic of India.
- 10.08.00 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquid shall not be stored inside the tunnel
- 10.09.00 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.
- 10.10.00 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.

11.00.00 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The **Contractor**, shall provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station".

Serious Injury

In case of serious injury, the following procedure shall be adopted by the **Contractor**:

- 1). Provide First Aid at his own First Aid Station.
- 2). Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.
- 3). Reporting the accident to the Owner/Engineer by the **Contractor**.

Fatal Accident

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

Penalty

Failure to observe the Safety Rules shall make the **Contractor** liable to penalty by way of suspension of work, fine and termination of bid.

12.00.00

GENERAL SAFETY PROVISIONS FOR COOLING TOWER AND CHIMNEY:

There are numerous safety aspects to consider in construction; they are affected not only by the structural and environmental aspects of the form and scaffold system in use, but also by the strength and stability of the partially completed structure.

The early age of the concrete is a critical item and can control the rate of progress. Similarly, the design, manufacture, and installation of anchorages in the young concrete are important items. Jump form systems rely heavily on strengths of previous lifts to resist construction loads and moments; vertical slip forms do not typically apply eccentric loads to lifts below but are dependent on the strength of concrete at very early ages.

Training of personnel is important to the safe operation of any construction system. It is a critical item in the use of jump form and slip form systems. The sequencing and execution of the many procedures involved can affect the overall safety of the system, including the partially completed structure. The **contractor** shall implement safety inspection procedures which shall be part of the field records. Personnel shall be made aware of the interrelationships of the various system components and be cautioned as to the critical elements.

Access ways shall be available for use at all times, without restrictions caused by debris or other items. Alternate routes must be made available in the event normal access is interrupted. Ladders between work levels shall be secured and available at all times; access hatches shall be clearly marked and available at any time.

CONSTRUCTION REVIEWS

Preconstruction reviews can be useful in acquainting jobsite personnel and other associated personnel with planned construction methods, form and scaffold systems, materials delivery systems, schedules, and overall operating procedures. Compliance officers can be informed of safety procedures to be in effect and notified of persons responsible for reporting. Preliminary discussions shall include basic construction procedures and schedules, as well as design loading criteria for the form and scaffold system. More specific procedures, schedules, and loads can be provided with design drawing submittals at a later time, but prior to starting construction.

Critical conditions or loads shall be clearly noted; key operations shall be denoted and appropriate safety measures put into effect.

Regular or periodic construction meetings can be effectively used to review progress of construction and to discuss changes to operating procedures, equipment, and/or personnel.

Specific bench marks shall be established for all key operations; these shall include, but not necessarily be confined to, minimum concrete strength for form removal, minimum concrete maturity, minimum size and number of anchor bolts, and their proper placement, sequence of operation, maximum deck loads, minimum size and number of scaffold connections, maximum concrete casting rates and size and spacing of form ties.

Inspections shall be adequate to assure the bench marks are being met. Job site records can be satisfactorily used to review many items. Some items will require detailed inspections to be performed.

There are a number of key factors influencing the overall structural integrity of moving formworks used in the construction of cooling towers and chimneys. The principal forming systems, which have been addressed in the respective sections, cannot be treated independently of the partially completed structure. The forms, scaffolds, moving mechanisms and the structure combine to form an interactive construction system in which the safety of individual components is affected by the design and operation of other components.

A working knowledge of the operational aspects of the systems will ensure meaningful field evaluation of system safety by compliance officers. Among critical safety items, the capacity of partially matured concrete to resist imposed construction loads with an adequate margin of safety shall receive foremost priority.

The minimum factor of safety shall be maintained at a level consistent with the design of concrete structures for occupancy loads for two important reasons.

First, service loads and fully developed concrete strength are more predictable than construction loads and the strength of concrete at early ages. Second, the consequences of a construction failure in terms of human casualties would be quite severe owing to the fact that moving form systems are generally well-populated and inherently limited in providing the exit ways for emergency evacuation of personnel in the event of structural distress.

In addition, where the partially cured concrete supports loads transmitted by scaffolds and other work platforms, its strength requirements shall be consistent with the safety factors prescribed by the construction safety regulations.

The compliance officer shall expect to find field records which will show, above all else, that the construction system is well-conceived and structurally sound with regard to the maintenance of a minimum factor of safety on component strengths. The engineer's records shall be sufficiently comprehensive to indicate, through a detailed set of specifications, critical

benchmarks for the movement of forms and imposition of loads on partially cured concrete.

The field logs shall show these bench marks are being met. The proper implementation of these items is the key requirement contained in regulations. Many of the safety hazards found in cooling tower and chimney construction are universal in application.

Access ways must be available at all times, without blockage by debris or other items. All structural connections of the scaffolding and forming systems must be sound and adequate for the intended loads. Any signs of distress in the system, such as cracking, peeling, bending, etc., shall be noted and remedial measures taken immediately. Structural engineering consultants may be needed in the evaluation of certain moving form systems which incorporate relatively complex mechanisms (such as catheads used in conjunction with flexible cables to transport concrete to the top of the tower) capable of producing extraordinary loads on the partially matured concrete structure.

13.00.00 CHECK LIST FOR INSPECTION OF JUMP FORM SYSTEM

REFERENCE DOCUMENTS

REVIEWED

Tower drawings
Formwork drawings
Formwork calculations
Sequence of moving cycle
Criteria for form movement
Concrete records
Material test records
Maintenance records

GENERAL		YES	NO
Overall formwork condition adequate		-----	-----
Routine maintenance performed		-----	-----
Regular inspections performed:			
Concrete	-----		
Anchorage	-----		
Access ways	-----		
Forms	-----		
Training provided for personnel		-----	
Form movement criteria observed		-----	-----
Signs of overload or structural distress		-----	-----
If answer is yes, explain further.			



CONCRETE	DESIGN	OBSERVED
28-day compressive strength	-----	-----
Max. slump, in.	-----	-----
Max. water/cement ratio	-----	-----
Min. compr.str. for form movement	-----	-----
Min. comp. str. for placing concrete in succeeding lift	-----	-----
General Comments:		

ANCHORAGES	DESIGN	OBSERVED
Design working load (in concrete, with safety factor)	-----	-----
-		
Shear	-----	-----
Tension	-----	-----
Nominal size of embedment	-----	-----
Nominal size of anchor bolt	-----	-----
Min. anch.bolts per strongback	-----	-----
General Comments:		

ACCESS/EGRESS	DESIGN	OBSERVED
Level 1 (Top) scaffold (..... simple..... braced..... Cantilevered)		
Live load	-----	-----
Spacing of scaffold brackets	-----	-----
Nom.bolt sizes	-----	-----
Level 2 Scaffold (..... Simple..... braced..... cantilevered)		
Live load	-----	-----
Spacing of scaffold brackets	-----	-----
Nom. bolt sizes	-----	-----
Level 3 Scaffold (..... simple..... braced..... cantilevered)		
Live load	-----	-----
Spacing of scaffold brackets	-----	-----
Nom. bolt sizes	-----	-----
Level 4 Scaffold {..... simple..... ..braced..... cantilevered)		





EPC Contract Document

NLC India Limited
NLC Talabira Thermal
Power Project - 3x800 MW
Jharsuguda, Odisha

Live load	-----	-----
Spacing of scaffold brackets	-----	-----
Nom. bolt sizes	-----	-----
Miscellaneous Comments:		
Ladders:	-----	
Stairs:	-----	
Elevators:	-----	
Guardrails:	-----	
Toe boards:	-----	
Maintenance:	-----	
General Comments:	-----	

HOISTING SYSTEM	DESIGN	OBSERVED
Main hoist line		
Min. sheave size	-----	-----
Min. line size	-----	-----
Static line		
Min. sheave size	-----	-----
Min. line size	-----	-----
Max. tension	-----	-----
Max. hoist load	-----	-----
General Comments:		

RAISERS	YES	NO
Mechanical components checked regularly	-----	-----
Safety mechanism operating properly	-----	-----
Regular maintenance performed	-----	-----
General Comments:		

CHECK LIST FOR INSPECTION OF SLIP FORM SYSTEM

REFERENCE DOCUMENTS	REVIEWED
Chimney / silo drawings	-----
Formwork drawings	-----
Formwork calculations	-----
Criteria for slipping rate	-----
Concrete records	-----
Material test records	-----
Maintenance records	-----





GENERAL	YES	NO
Overall formwork condition adequate	-----	-----
Routine maintenance performed	-----	-----
Regular inspections performed	-----	-----
Concrete	-----	-----
Climbing rods	-----	-----
Anchorage	-----	-----
Access ways	-----	-----
Forms	-----	-----
Training provided for personnel	-----	-----
Form slipping criteria observed	-----	-----
Signs of overload or structural distress	-----	-----
If answer is yes, explain further	-----	

CONCRETE	DESIGN	OBSERVED
28-day compressive strength-----	-----	-----
Max. slump in.	-----	-----
Max. water/cement ratio	-----	-----

CLIMBING RODS	DESIGN	OBSERVED
Diameter of rods	-----	-----
Unbraced length	-----	-----
Dist between climbing rods	-----	-----
General Comments:	-----	

ANCHORAGE (climbing mast system)	DESIGN	OBSERVED
Design working load (in concrete, with safety factor) -----	-----	-----
Shear	-----	-----
Tension	-----	-----
Nominal size of embedment	-----	-----
Nominal size of anchor bolt	-----	-----
General Comments:	-----	

ACCESS/EGRESS	DESIGN	OBSERVED
Main work deck Live load, psf	-----	-----
Level I (TOP) scaffold (..... ..simple.....braced.....cantilevered)		
Live load	-----	-----
Spacing of scaffold brackets	-----	-----
Nom. bolt sizes	-----	-----
Level 2 scaffold (... simple..... Braced.....cantilevered)		
Live load	-----	-----
Spacing of scaffolds brackets	-----	-----





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Nom. bolt sizes _____

Level 3 scaffold [..... simple.....Braced.....cantilevered)

Live load _____

Spacing of scaffold brackets _____

Nom. bolt sizes _____

Miscellaneous Comments:

Ladders: _____

Stairs: _____

Elevators: _____

Guardrails: _____

Toe boards: _____

Maintenance: _____

General Comments: _____

YOKES/HYDRAULIC JACKS	YES	NO
Level controls	_____	_____
adequate Safety mechanisms	_____	_____
operating properly	_____	_____
Regular maintenance performed	_____	_____
General Comments:	_____	





EPC Contract Document

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NLC Talabira Thermal
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**VOLUME: II-G/2
PART-B**

SECTION-XX

**GUIDELINE FOR
FENCING WORK WITH BARBED WIRE, CHAIN LINK
AND
CONCERTINA COIL etc.**



Development Consultants Pvt. Ltd.

Vol. II-G2/Part-B/Section-XX
Fencing Work With Barbed Wire,
Chain Link and Concertina Coil Etc.



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**VOLUME: II-G/2
PART-B**

SECTION-XX

**GUIDELINE
FOR
FENCING WORK WITH BARBED WIRE,
CHAIN LINK AND CONCERTINA COIL etc.**

1.00.00 SCOPE

This section covers supply, fabrication and erection of chain link fencing, barbed wire fencing, concertina coil etc. as specified or shown on drawing or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc



chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Posts and Struts

2.02.01 M.S. Posts and Struts

All the M.S. posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the **contract** schedule and drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete of mix.1:2:4 or as specified in the schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

2.02.02 R.C.C. Posts and Struts

All the posts and struts shall be of standard size as specified in schedule. These shall be casted on suitable places/platforms in cement concrete 1:1.5:3 (1 cement : 1.5 coarse sand : 3 graded stone aggregate 12.5 mm. nominal size) as per relevant specifications stipulated here-in-before. The reinforcement shall be provided as shown in the drawings, as directed by Engineer-in-Charge and specified here-in-before under relevant sections. The posts and struts shall be free from honeycombing, cracks and other defects.

After casting, the posts/struts shall be left at the same place and cured for a minimum period of 7 days. After 7 days curing the same shall be shifted to a leveled ground and stacked for further curing for 14 days. After 21 days of curing only, the posts/struts shall be transported to work site without any damage, for fixing in position.

2.02.03 Spacing of the Posts and Struts

The spacing of posts shall be 3 m. centre to centre unless otherwise specified or as directed by the Engineer-in Charge, to suit the dimensions of the area to be fenced. Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer-in-Charge. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

2.02.04

Fixing of M.S./R.C.C. Posts and Struts

Pits of size 45 x 45 x 45 cm. deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, the pits shall be so excavated, as to receive minimum 15 cm. concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

The pits shall be filled with a layer of 15 cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix. shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for at least 7 days to ensure proper curing.

3.00.00

G.I. Barbed Wire

The barbed wire shall be of G.I. as specified and it shall generally conform to I.S. 278-2009.

The base metal of the line and point wire shall be of good commercial quality mild steel conforming to IS: 280-2006. The line and point wire shall be circular in section, free from scales and other defects and shall be uniformly galvanized, if specified.

The line wire shall be in continuous lengths and shall generally be free from signs of welds. It shall be able to withstand Wrapping and unwrapping 8 turns round its diameter.

The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting two lines wires one containing the barbs.

The barbed wire and its weight

Type	Nominal diameter of wire		Nominal distance between two barbs(in mm.)	Mass of complete barbed wire(in gm./m.)
	Line wire (in mm.)	Point wire (in mm.)		
1.	2.50(12G)	2.50(12G)	75	146 (136-155)
2.	2.50	2.50	150	114(108-120)
3.	2.50	2.00(14G)	75	117(108-125)
4.	2.50	2.00	150	96(89-103)
5.	2.24(13G)	2.00	75	102(97-106)
6.	2.24	2.00	150	82(78-85)

The barbs shall carry four points and shall be formed by twisting two point wires, each two turns, tightly round one line wire, making altogether 4 (four) complete turns. The barbs shall be so finished that the four points are set and locked at right angles to each other.

The barbs shall have a length of not less than 13 mm. and not more than 18 mm. The points shall be sharp and well pointed. Barbs spacing shall be as given in the above table. Wherever required for every 50 reels or part thereof, samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

Tensile Properties

Size of line wire Nominal dia. (in mm)	Breaking load of line wire		Min. breaking load of complete barbed wire (in Kg.)
	Min. (in Kg.)	Max. (inKg.)	
2.50(12G)	216	302	444
2.24(13G)	128	179	263

On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded as the case may be.

3.00.01 Fixing of Barbed Wire:

The barbed wire shall be stretched and fixed in number of rows and two diagonals as specified. The bottom row shall be 140 mm. above ground and the rest at 125 mm or at given spacing as per drawing. The diagonals shall be stretched between adjacent posts from top wire of one post to the bottom wire of the 2nd post. The diagonal wires will be interwoven with horizontal wires by fixing the odd rows of wires, then the diagonal cross wires and lastly the even rows of wires. The jointing of the barbed wire in between the posts shall not be permitted.

Necessary holes shall be tapped in the post and the barbed wire shall be fixed in position by means of 'U' clamps or bolts and nuts as specified in drawings. In case of fixing with 'U' clamps, the legs of the 'U' clamps passing through the 10 mm. dia. hole in the R.C.C. post to hold barbed wire shall be turned up and down to get an over-lap of 25 mm. on the face of RCC post. Turn buckles and straining bolts shall be used at the end posts if specified.

3.00.02 Mode of Measurement:

The work shall be measured in running metre length of fencing correct to a centimetre for the finished work, from centre to centre of the posts.

The rate shall include the cost of labour and materials involved in all the operations described above including the cost of barbed wire, turn buckle, straining bolts, bolts and the nuts/U clamps including excavation and foundation concrete or as specified in item description for the work.

4.00.00 Chain Link

The chain link shall be of approved manufacture and of correct size, gauge etc. It shall be of M.S. or G.I. as specified of approved manufacture and of required size, gauge etc. The base materials of the wire shall be of good commercial quality mild steel conforming to IS:280-2006. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanized, if specified.

4.00.01 Fixing of the Chain Link Fencing to M.S. or R.C.C post

The chain link of specified height of fencing shall be fixed first to the end post with necessary G.I. approved type U clamps threaded at the ends and G.I. nut, bolts, washers etc. and with 6 mm. dia. full height M.S./G.I. anchor bar. After fixing the chain link at the end post, it shall be stretched tightly and fixed to next post one after the other by the above mentioned clamps and bars etc. leaving 50 mm. clearance from the ground and 20 mm. clearance in the case of concrete coping at bottom to avoid rusting. The point at the change in level of the fencing top/bottom, necessary links shall be adjusted suitably as per the manufacturer's specification or as directed by the Engineer-in-Charge. The chain link fence post shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer or as specified in the item/drawing.

4.00.02 Measurement:

The work shall be measured in running metre length of fencing correct to a centimetre for the finished work from centre to centre of the posts.

The rate shall include the cost of labour and material involved in all the operation described above including the cost of barbed wire, turn buckle, straining bolts and bolts and the nuts/U clamps, 6 mm. dia. M.S./G.I. anchor bar etc. including excavation and foundation concrete or as specified in item description for the work.

5.00.00 Concertina Coil Fencing

5.00.01 Materials

- i) Angle iron post & strut shall be as specified in item no. 2.02.00
- ii) Punched tape Concertina coils shall be manufactured using central core of High Tensile G.I. Spring steel core wire of 2.60 mm dia. around which a tape of razor sharp blades (Low carbon G.I strip) of thickness 0.52mm, is machine crimped. Concertina coil fencing shall be of specified diameter such as 450mm, 600mm, 750mm, 900mm, having 10 to 8 turns (loops) per running metre length of coil and shall be of approved manufacturer.

5.00.02 Spacing of Posts & Struts:

The spacing of posts shall be 2.4 m or 3.00 m apart centre to centre, unless otherwise specified or as per Engineer-in-Charge to suit the dimension of the area to be fenced. Every 15th last but one end posts and corner posts shall be strutted on both sides and end posts on one side only.

5.00.03 Fixing of Posts and Struts:

As per drawing and as specified in item no. 2.02.00 in this specification..

5.00.04 Fixing concertina coil fencing:

Concertina coil fencing shall be fixed on angle iron y-shaped with 9 horizontal reinforced barbed tape (RBT) stud tied with GI staples and GI clips to retain horizontal including necessary bolts or GI barbed wire tied to angle iron all complete as per directions of Engineer-in-Charge with reinforced barbed tape.

5.00.05 Measurements:

The length of Concertina coil fencing shall be measured correct to a cm for finished work. Angle iron post & strut shall be paid separately under relevant item.

6.00.00 Acceptance Criteria

- a) All items shall be correct shape, size, weight etc. shown on drawing and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from straightness—1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blow holes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain and shall not bulge.

7.00.00 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.



ISCODES

IS:278	Specification for Galvanised Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners—Threaded steel fasteners- Technical supply condition.
IS:2721	Specification for Galvanised Steel Chain Link fence fabric.

